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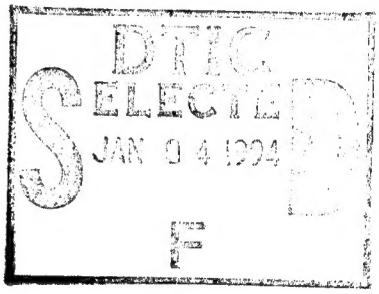
THERMAL ANALYSIS AND DEVELOPMENT OF RATION PACKAGING FOR EFFICIENT HEATING WITH FLAMELESS ELECTROCHEMICAL HEATERS



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13. ABSTRACT *(Maximum 200 words)*

The investigation has been conducted to study the transient thermal performance of food-packages containing integral exothermic chemical heaters using Finite Element Analysis (FEA). The work was divided in two parts. The first part deals with the Meals Ready to Eat (MRE) packages, and the second part deals with the Self Heating Individual Meal Module (SHIMM). The MRE study was focused on developing tools to model the thermal characteristics of the heater and the MRE entree. Experiments were performed to obtain temperature profiles in the self heating ration packages under field like conditions. The FEA indicated that distributing the steam uniformly over the entire top surface of the package resulted in the latent heat of vaporization of the steam being transferred to the food rapidly. By exploiting the condensation mechanism, the mass of the heater could be decreased by up to 50%. In the study on the SHIMM, a three dimensional thermal transient analysis was conducted. A number of experiments were also conducted on plain and modified heater geometries for the SHIMM. The FEA predictions agreed well with the experimental results.

14. SUBJECT TERMS

THERMAL ANALYSIS, FINITE ELEMENT ANALYSIS, FIELD FEEDING, FLAMELESS, FIELD RATIONS, FLAMELESS RATION HEATER (FRH), HOT MEALS, RATIONS, SELF HEATING, MRE(MEAL READY-TO-EAT), PACKAGING, HEATING, FLAMELESS BURNERS, MILITARY RATIONS

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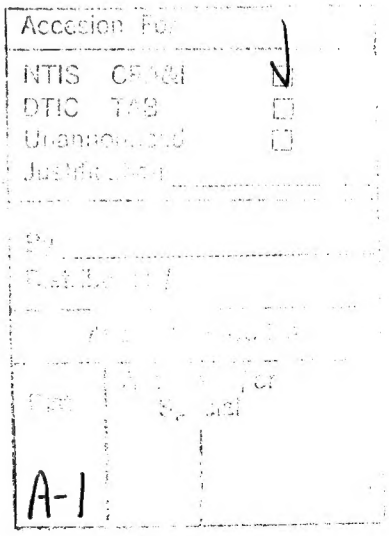

PREFACE

This study was conducted to study the transient thermal performance of food packages containing integral exothermic chemical heaters using two and three dimensional finite element approaches. The work was divided in two parts. The first part deals with the investigation of the Meal Ready to Eat (MRE) packages, and the second part deals with the Self Heating Individual Meal Module (SHIMM) with a tub configuration.

This effort was undertaken by Rochester Institute of Technology under contract no. DAAK-60-91-K-0003. The effort was conducted from March 1991 to April 1992.

The authors gratefully acknowledge the contributions of Mr. Donald Pickard, and Mr. Il Young Kim of the Food Engineering Directorate (FED), for their guidance and assistance in providing material data properties for the analysis.

Following the transfer of Mr. Il Young Kim to the Science and Technology Directorate, this technical report was completed through the publication process by Mr. Keith Nelson.

THERMAL ANALYSIS AND DEVELOPMENT OF RATION PACKAGING FOR EFFICIENT HEATING WITH FLAMELESS ELECTROCHEMICAL HEATERS

Part A - Experimental Studies on MREs.

1.0 Introduction

This section of the report covers the work done at the Rochester Institute of Technology's Thermal Analysis Laboratory from March 1991 through March 1992 under US Army, Natick Contract No. DAAK-60-91-K-003. The Meal Ready to Eat (MRE) is an individual packaged ration used by the US Army. The Flameless Ration Heater (FRH) was recently introduced as a means to serve soldiers a hot meal by giving them the means to heat the MRE entree. The FRH utilizes a water activated exothermic chemical reaction to heat the MRE entree. The FRH generates steam and hydrogen gas during the reaction. Kandlikar (1990) observed that the steam generation, flow and escape mechanisms could be important in the heating process. As a first part of the study, the goal of the work at the Thermal Analysis Laboratory has been to develop a computer model which will accurately predict heat transfer rates and final temperatures within a packaged ration heated with FRH systems. An experimental baseline has been developed for the current system using a diffuser to direct the flow of the steam and hydrogen gas. Computer simulations have been developed using ANSYS and have been refined to correctly predict the experimental results.

2.0 Experimentation

2.1 Experimental Apparatus

Figure 1 shows a schematic of the basic configuration of the experimental apparatus, used for the experimentation. This simplified diagram shows the electrical interconnections of the different devices and identifies each item.

2.2 Instruments

2.2.1 Keithley Scanning Thermometer

The Keithley Model 740 System Scanning Thermometer supports a maximum of 90 channels, accessed through up to 10 7402 Thermocouple Scanner cards. The 740 System supports J,K,E,T,R,S, and B type thermocouples as well as millivolt devices. Temperature may be indicated in either Fahrenheit or Celsius scales.

2.2.2 National Instruments GPIB Interface

A National Instruments PCII-A GPIB (General Purpose Interface Bus) card is used in the IBM PC and is connected to the scanner via a GPIB cable.

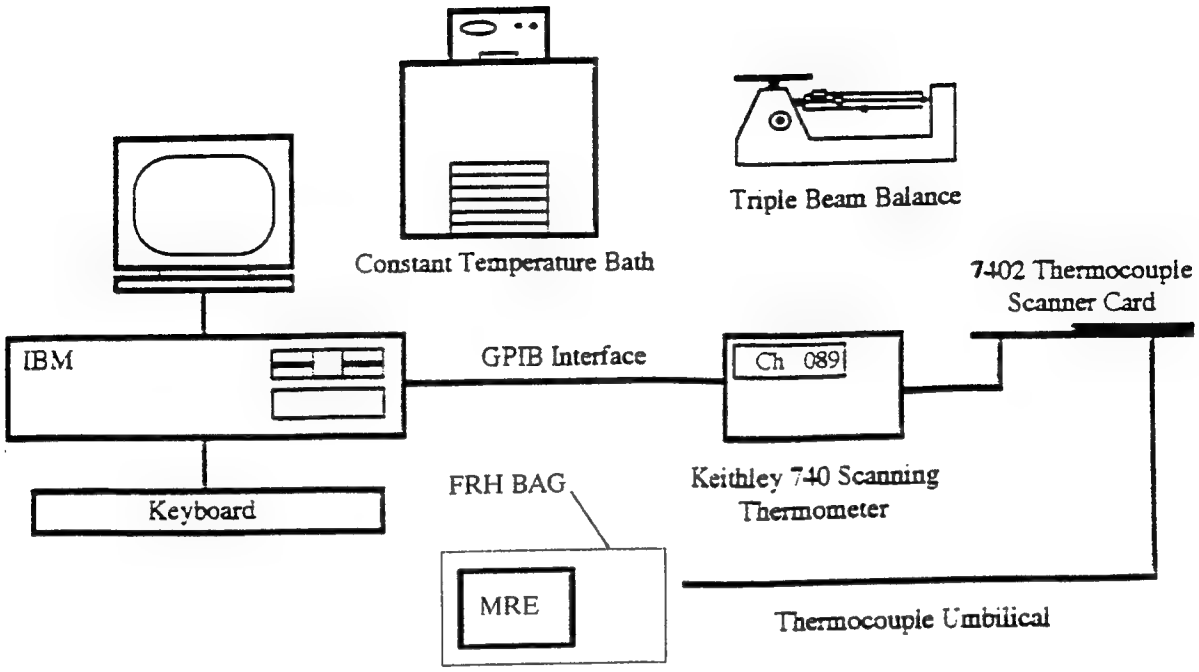

Figure 1
Test System Schematic

2.2.3 Data Acquistion Computer

A computer with a hard drive is used to run the control software and store data in either a file or a buffer for post-processing. The tabulated temperature information may be displayed directly on the screen, stored in an internal buffer, or written to a file on either the hard drive or on the floppy disk drive. Data for each individual channel stored in the buffer may be plotted on Temperature vs. Time axes on the CGA monitor after data collection has ceased. Data written to a disk file is stored in ASCII format and may be edited for entry into a spreadsheet or database.

2.2.4 ASYST Software

The control software was written using Asyst, a forth-based programming language supplied by Keithley-ASYST. This language is responsible for the menuing structure and the data collection routines which control the Keithley 740 scanning thermometer through the GPIB interface.

2.2.5 Brinkman RC20 Constant Temperature Bath

The Brinkman RC20 constant temperature bath is a device capable of heating or cooling its working fluid to maintain a temperature within $\pm 0.1^{\circ}C$ of the set point.

The set point range is from -30°C to +150°C.

2.2.6 Ohaus Triple Beam Balance

An Ohaus triple beam balance is used to measure the masses of the FRH and the activating water used in each experiment.

2.3 Equipment Configuration

2.3.1 Thermocouple Scanner

The 740 System Scanning Thermometer has a removable 7402 Thermocouple Scanner input card which slides into the back of the 740. Removing the card allows access to the thermocouple scanner input block, and the input terminals for each of the channels numbered 2 through 10 as well as the output terminals. The 7402 output terminals are connected to the 740 scanning system input terminal strip. Currently, only nine channels may be acquired simultaneously.

2.3.2 Data Acquisition Computer

The acquisition and control program is run after the power to all devices has been turned on. The acquisition portion of the program is configured at run time. The following configuration parameters were selected:

- thermocouple type for each channel #2-#10 - T,J,J,J,J,J,J,J,J
- number of data points to be taken, 22
- seconds-per-point, 15
- temperature scale, Celsius
- output to [filename] on hard drive

2.3.3 Constant Temperature Bath

The constant temperature bath is filled with distilled water and turned on. The set point is set to 30.0°C.

2.4 Experimental Procedure -- Baseline

Three experiments were performed under simulated field conditions. The experiments consisted of taping the thermocouples to their designated locations, as shown in Figure 2, in the MRE entree and on the surface of its packaging. The FRH bag was opened and the FRH mass was measured and recorded. The temperatures of the FRH, MRE, and packaging were recorded. The FRH, MRE and the thermocouple umbilical were inserted into the bag.

Next, water was drawn from the constant temperature bath and measured to a mass of 59.2 grams, (2.0 fluid ounces), to ensure consistency. The water was poured into the FRH bag, the top of the bag was folded over, and the ration was rocked back and forth to ensure good wetting of the FRH. Finally, the FRH bag and its contents were slid into the original paperboard carton packaging for the MRE entree with the heater towards the bottom. The entire assembly was placed in an inclined position using a support as shown in the FRH directions. The data acquisition system was started and ran for 300 seconds. At the end of the 300 seconds, the MRE and the thermocouple umbilical were removed from all packaging materials and from the FRH. The MRE was kneaded for approximately 15 seconds to attain a uniform temperature. The final average temperature of the MRE was recorded using the internal T-type thermocouple.

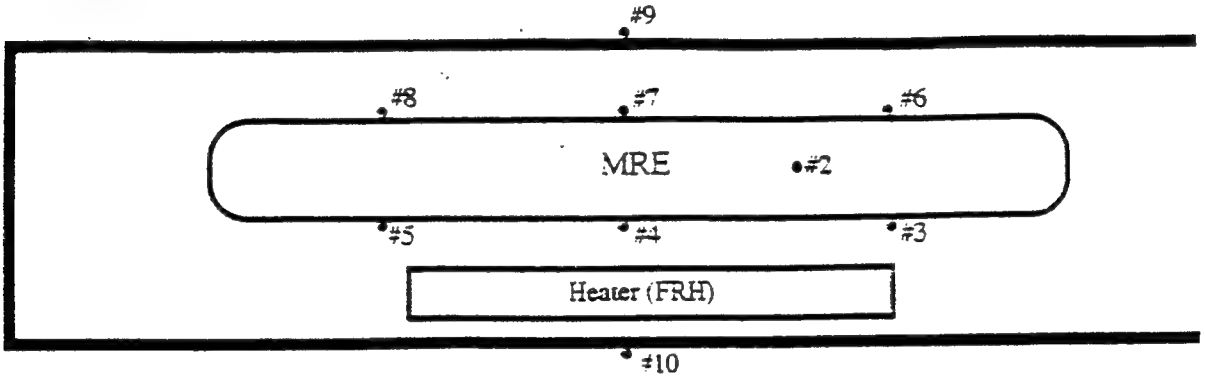

Figure 2
Thermocouple Location Detail

2.5 Modification of existing system

Testing indicated that the existing system might be altered to obtain a better heating of the MRE using the FRH. This indication was borne out of the work done by Kandlikar (1990). Kandlikar observed that the steam escaped from the packaging in narrow channels formed between the heater bag and the packaged ration. This led to experimentation which was conducted on the existing MRE and FRH. A steam/vapor diffuser was developed for the purpose of diffusing the steam and hydrogen gas over the entire upper surface of the packaged ration.

2.5.1 Diffuser design

The diffuser was constructed using a simple wooden mold, and a thermo formalble plastic sheet. The mold was constructed using 1/8 inch diameter dowels as the primary forming components. The dowels were placed on 10 mm centers, to form 10 channels running the length of the MRE. Since the diffuser actually had a set of channels on each side, it would have allowed steam to escape on the side opposite the package ration. It was consequently decided to seal the opposite side of the diffuser with tape.

2.6 Experimental procedure -- Diffuser variation

The procedure for conducting the experiments with the diffuser is similar to that for the baseline experimentation with the following exceptions. In addition to the MRE, FRH, and thermocouple umbilical which are inserted into the FRH bag, the diffuser is inserted as far as the top of the packaged ration. After the water is added, the diffuser and the top of the FRH bag are folded over the back of the ration to direct and distribute the steam and hydrogen gas. The diffuser directs steam over the side of the ration opposite the heater. The FRH bag, its contents, and the diffuser are slid into the original carton with the heater towards the bottom. The rest of the experimental procedure remains the same.

3.0 Experimental Results

The final average temperatures for the current MRE, FRH system ranged from 53.5°C (128°F) to 55.5°C (132°F), giving an average of 54.7°C (130.4°F). The final average temperatures for the MRE, FRH system using the diffuser ranged from 60.0°C (140°F) to 65.5°C (150°F), with an average of 62.5°C (144.5°F). The average temperature increase for the current system was 29.2°C (52.6°F). The average temperature rise for the diffuser system was 36.0°C (64.8°F). This shows that by using the diffuser, the ration's average temperature could be increased by 6.8°C (12.2°F) over the baseline temperature. These results are shown in Table 1 and Figure 3. A performance index relative to the current system has also been calculated.

Table 1. Experimental Results

Experimental Results		
	Current	Diffuser
ΔT_1	29.6°C (53.2°F)	32.0°C (57.6°F)
ΔT_2	30.0°C (54.0°F)	40.5°C (72.9°F)
ΔT_3	28.0°C (50.4°F)	35.6°C (64.1°F)
Average ΔT	29.2°C (52.6°F)	36.0°C (64.8°F)
Performance	1.00	1.23

The entire set of temperature results are presented in Appendix A.

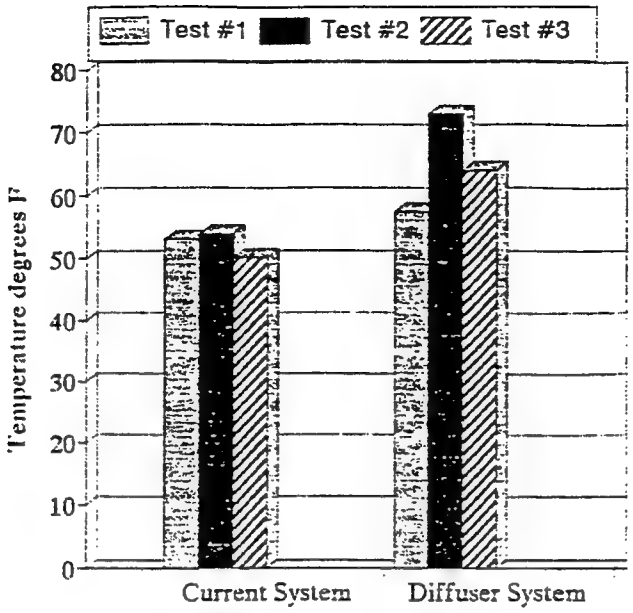

Figure 3
Final Temperature Comparison

4.0 Analysis of Experimental Results

The temperature values for each experimental condition have been averaged over three trials of each scenario to obtain an average temperature. These average temperatures have been normalized against the maximum and minimum temperatures in each of the two experimental scenarios using equation (1).

$$T^* = \left(\frac{T_{avg} - T_{min}}{T_{max} - T_{min}} \right) \tag{1}$$

Where T^* is the non-dimensional temperature
T_{min} is the minimum absolute (°K, °R) temperature for the particular system
T_{max} is the maximum absolute (°K, °R) temperature for the particular system
Further, time was normalized with respect to the final time using equation (2).

$$t^* = \frac{t}{t_f} \tag{2}$$

Where t^* is the non-dimensional time
t is the time in seconds
t_f is the final time in seconds

By applying these two equations to the averaged data for each location, non-dimensional plots were generated. Samples of these plots are shown in Figures 4 through 6. Each figure is a plot of non-dimensional temperature as a function of the non-dimensional time

at an indicated location. The square symbols represent the baseline data and the crosses represent the data generated using the diffuser. A discussion of the individual plots accompanies the figures.

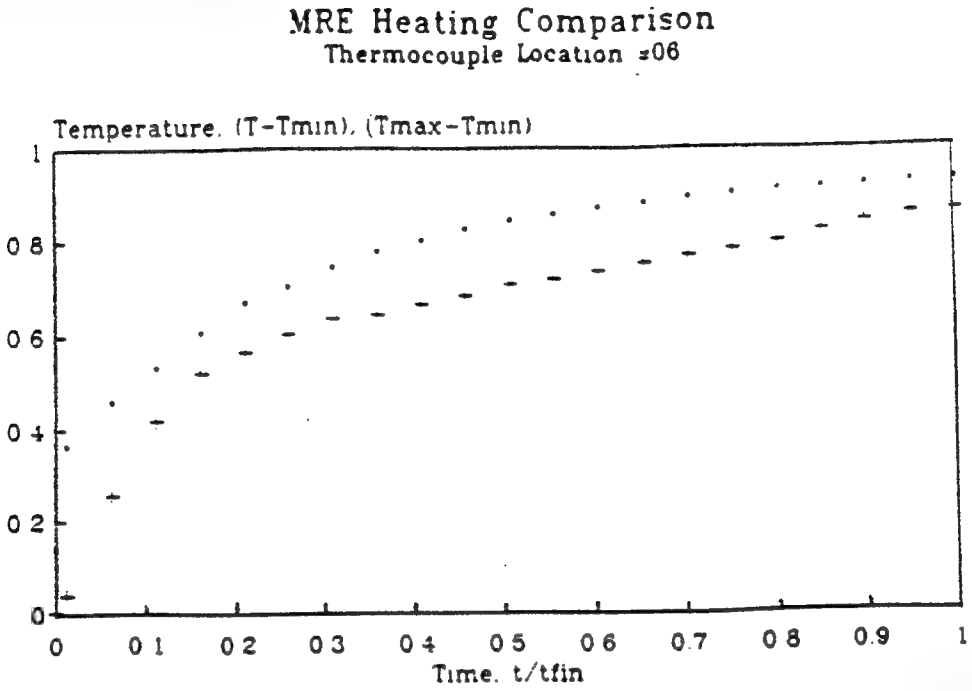

Figure 4. The greater baseline temperatures are most likely due to the channeling of steam in the baseline case. This effect may have been exaggerated by the presence of the thermocouple wires which would have formed a standing channel.

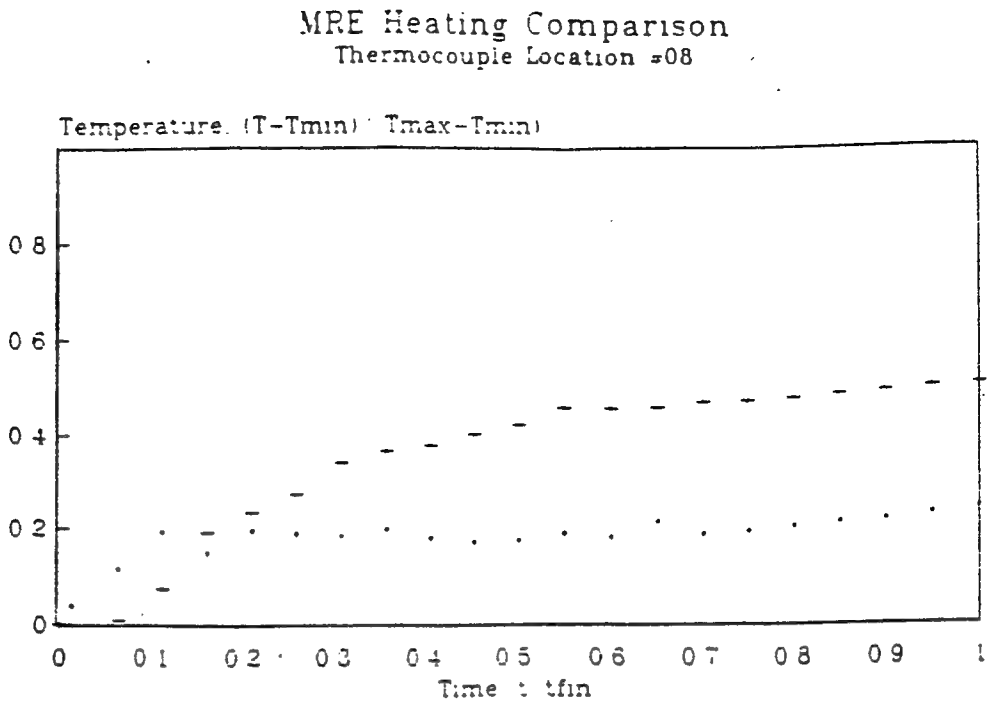

Figure 5. The temperatures show a marked increase for the diffuser scenario. The reason for the increase is that in the baseline scenario, the steam has escaped and left the packaging before making it to location #8.

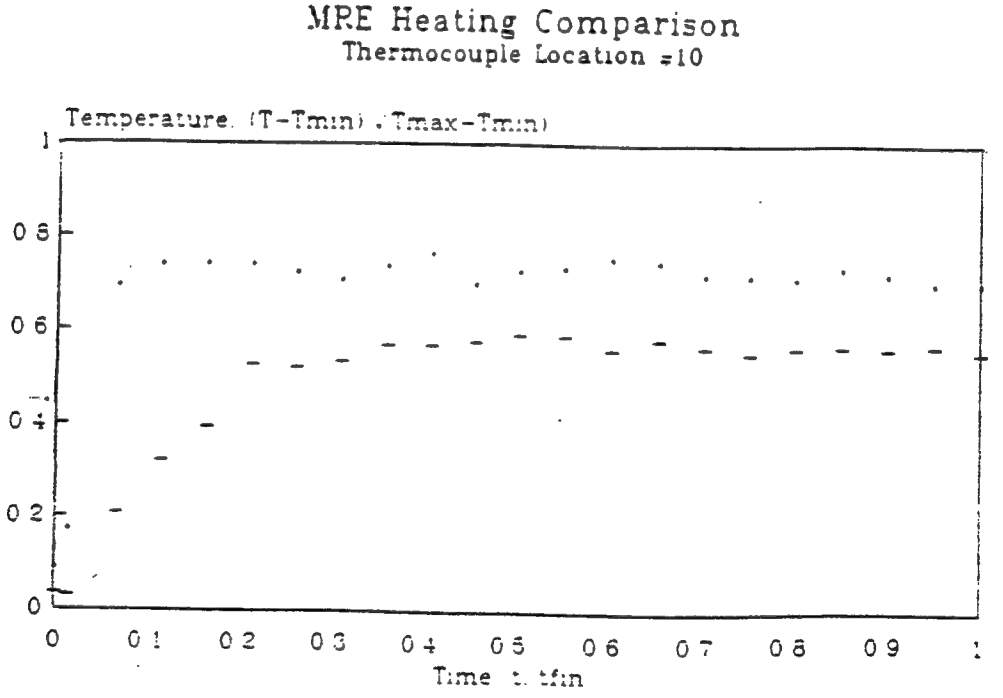

Figure 6. The current system temperatures are comparatively higher than the diffuser system's, indicating that more of heat is lost to the environment in the current system. More heat is put into the MRE using the diffuser. The diffuser also provides additional insulation between the MRE and the carton in addition to increased heat transfer into the MRE.

Part B – Numerical Modelling of MREs USING ANSYS - Thermal Analysis.

6.0 Overview of Numerical Studies

The purpose of this study was to determine the temperature distribution as a function of time and the final average temperature in an MRE model using a finite element approach. Transient thermal analyses were performed using an initial temperature and finite temperatures applied on the model boundaries. In any numerical technique, the convergence and stability of the solution are of primary interest. For explicit numerical techniques applied to transient thermal problems, the maximum time step between iterations is determined by the element conduction length and the material's thermal diffusivity. This provides an estimate for the maximum time step allowed in the finite element method.

7.0 Introduction to the ANSYS Program

The ANSYS is a Finite Element package that was introduced in 1970 by Dr. John Swanson of the Swanson Analysis Systems, Inc.. The ANSYS program is a general purpose finite element program which includes a variety of analysis capabilities for linear and nonlinear structures. These capabilities include static, modal, transient dynamic, and harmonic response analysis. The ANSYS consists of Preprocessor, Analysis, and Post-processor modules. The program is graphics oriented, depending heavily on graphic displays for verifying user supplied information during preprocessing, and for retrieving ANSYS calculated results in the post-processors.

7.1 Preprocessing

The model creation is done in the Preprocessing phase. The element type and material properties are specified. A sample input file may be seen in Appendix B. For the transient analysis the time step and number of iterations are also set. For this investigation, a time step optimization was invoked within ANSYS. The optimization routine looks at the radius of curvature of the second derivative of temperature with respect to time. If this radius of curvature is large, the time step is sufficiently small and may be increased. If the radius of curvature is small, the time step must be decreased to obtain a stable convergent solution. By using the optimization routine, computing requirements are minimized.

7.2 Processing

The processing or solution phase analyzes the problem and sends the output to a file that can be accessed by the Post processor. A partial output file may be seen in Appendix C. This sample shows the analysis through the second iteration of load step two. The analysis yields temperature, heat flux and stress values at each node in the model for different time steps.

7.3 Post-Processing

There are two kinds of Post processors available, one is a general database processor and the other. is a time history processor. The general database processor produces stress plots, temperature-distance plots and lists nodal temperature and heat flux at different time steps. The time history processor produces temperature vs. time plots for single nodes. The general database processor is used to generate isothermal plots of the 2-D model.

8.0 ANSYS Model:

NOTE: Dimensions are in British Thermal Units for this model.

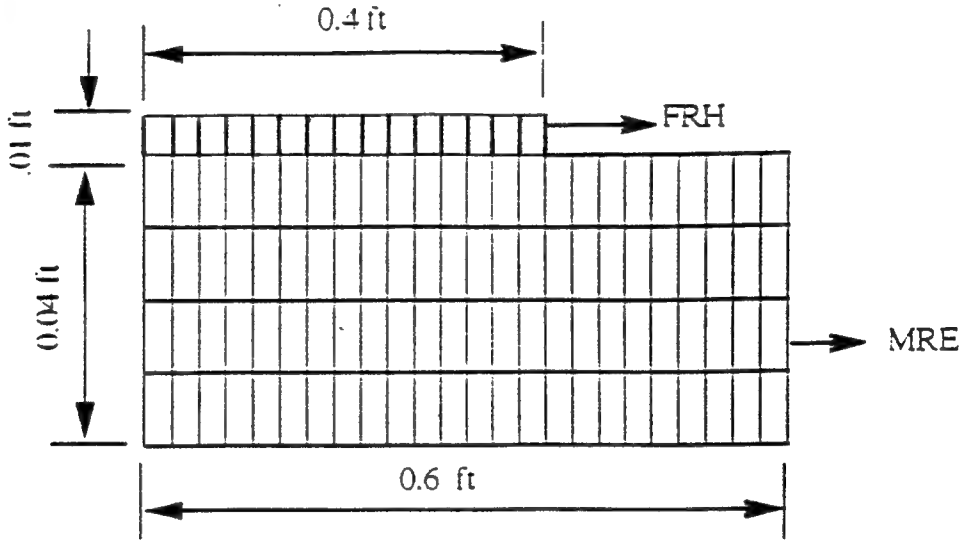

Figure 7
ANSYS Model

8.1 Model details

Table 2.

Model Properties

FRH(Flameless Ration Heater)	MRE(Meal Ready to Eat)
1. Specific Heat (C_p) = 2930 J/kg-K (0.70 BTU/lb-°F) 2. Density (p) = 1300 kg/m^3 (81.15 lb/ft^3) 3. Thermal Conductivity (k) = 0.678 W/m-K (0.392 BTU/hr-ft-°F)	1. Specific Heat (C_p) = 3200 J/kg-K (0.76 BTU/lb-°F) 2. Density (p) = 900 kg/m^3 (56.18 lb/ft^3) 3. Thermal Conductivity (k) = 0.580 W/m-K (0.335 BTU/hr-ft-°F)

9.0 Finite Element Modeling of MREs

As discussed earlier, the ANSYS program consists of Preprocessing, Analysis, and Postprocessing stages. In the Preprocessing stage the type of analysis for the MRE was specified as Transient thermal analysis and the element type, a 2-D, 4-noded quadrilateral thermal solid. Material properties were chosen from the model details specified. The present heating configuration was obtained by first creating a model with 142 nodes and 112 elements at specific intervals to match the actual MRE. For the initial condition, (Time = 0 seconds), a uniform temperature of 25°C (77°F) was applied at every node. One hundred iterations were specified for a total time of 300 seconds.

9.1 Present heating configuration

As was described earlier, the present heating conditions are adiabatic in nature. The steam that is generated, escapes in narrow channels, having little effect on the heating process. For this model, the initial uniform temperature was chosen to be 25°C (77°F). At Time > 0 the FRH temperature was increased to 87.8°C (190°F), and all other boundaries remained adiabatic.

9.2 Modified heating configuration

The modified heating condition was modeled using an approximation for the condensation of steam on the surface of the food pouch. The condensation, a convection process, was modeled by applying constant temperatures on the boundary. Six temperatures were selected for the convection modeling: 48.9°C (120°F), 60.0°C (140°F), 71.1°C (160°F), 82.2°C (180°F), 87.8°C (190°F), and 90.6°C (195°F). For each case, the FRH was maintained at 87.8°C (190°F) for all the applied boundary temperatures. As in the present heating configuration, the initial steady state condition was prescribed to be 25°C (77°F) at Time = 0. At Time > 0, the boundary temperatures were maintained at the temperatures mentioned above with the FRH being maintained at 87.8°C (190°F). The temperature distributions were obtained for the various cases.

10.0 Results

The mean temperature values for the six boundary conditions were obtained for two specific conditions, FRH being maintained at 87.8°C (190°F) and 90.6°C (195°F) respectively. Only the results of the 87.8°C (190°F) cases are presented here. The average temperatures were calculated by averaging the temperatures linearly over all of the nodes. The results of the averaging process are presented in Table III as Appendix E. Appendix E also contains all of the nodal temperatures for each ANSYS case.

Table 3.

ANSYS Results

ANSYS Results		
Case	Final Average Temperature	ΔT
Adiabatic	56.8°C (134.21°F)	31.8°C (57.2°F)
T_s = 48.9°C (120°F)	61.5°C (142.7°F)	36.5°C (65.7°F)
T_s = 60.0°C (140°F)	68.9°C (156.0°F)	43.9°C (79.0°F)
T_s = 71.1°C (160°F)	76.3°C (169.4°F)	51.3°C (92.3°F)
T_s = 82.2°C (180°F)	83.7°C (182.7°F)	58.7°C (106.°F)
T_s = 87.8°C (190°F)	87.5°C (189.4°F)	62.5°C (113.°F)

11.0 Comparison with Experimental Work

The ANSYS results correspond well to the experimental results. In the first case, the current system, an average ΔT of 29.2°C (52.6°F) was recorded. The ANSYS result of 56.8°C, ΔT=31.8°C, corresponds well to the experimental result. The current system is not truly adiabatic, and this explains the larger error. The ANSYS case, which used a boundary condition of 49°C (120°F) also matches the experimental results well. The four other cases considered using ANSYS do not have experimental parallels. The complete comparison is presented in Table 4.

Table 4.

Comparison of Results

Comparison of Results			
Case	Experimental	ANSYS	ANSYS error
Current System	29.2°C (52.6°F)	31.8°C (57.2°F)	8.90%
Diffuser System	36.0°C (64.8°F)	36.5°C (65.7°F)	1.39%

12.0 Summary of MRE work

The work done so far, allows the application of ANSYS to geometries similar to the existing MRE food pouch. It has been noted that at the current reaction rates, the FRH has a great deal of heat generating capacity left at the end of the five minute heating period. The use of a diffuser has been shown to increase the heat transferred to the food item, while decreasing the heat lost to the environment. The current diffuser is made of a relatively thick sheet of thermoforming plastic. A much thinner sheet will direct the flow adequately, with less mass to be heated by the FRH.

Part C -- Experimental Work on Tub Geometry

13.0 Introduction

This report section covers the experimental work done at the Rochester Institute of Technology's Thermal Analysis Laboratory from September 1991 through March 1992 under US Army, Natick Contract No. DAAK-60-91-K-003. The tub geometry , shown in Figure 8, has been designed as a more attractive individual packaged ration to replace the existing MRE. The tub configuration contains an FRH as a means for the soldier to heat the meal. The goal for this work has been to develop an ANSYS model to correctly predict the heat transfer rates and temperature distributions within geometries similar to the tub. This has been done by adjusting the ANSYS model to arrive at the proper temperature distributions as determined by testing of the tub configuration in the RIT Thermal Analysis Laboratory.

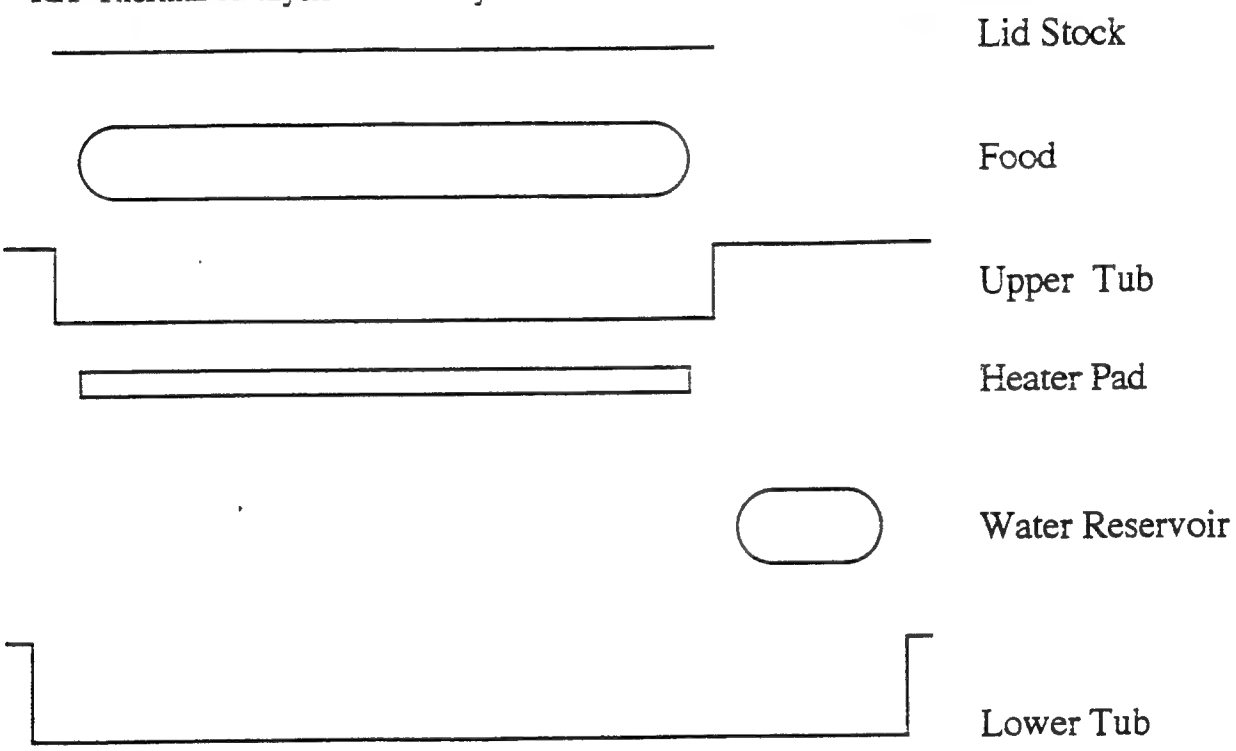

Figure 8
Tub geometry

14.0 Experimentation

For the tub geometry, four different sets of experiments were conducted. In the first set the existing tub design was heated using a full-size heater and two ounces of water, with everything initially at room temperature. The second set of experiments used a full heater with grooves in it, two ounces of water, with everything initially at room temperature. The third set used a half-size heater and one ounce of water with everything beginning at room temperature. The final set used full-size heaters and two ounces of water with initial temperatures just above freezing.

14.1 Experimental Apparatus

Figure 9 shows a schematic of the apparatus used in this experimentation. This simplified drawing shows the necessary connections and identifies each item.

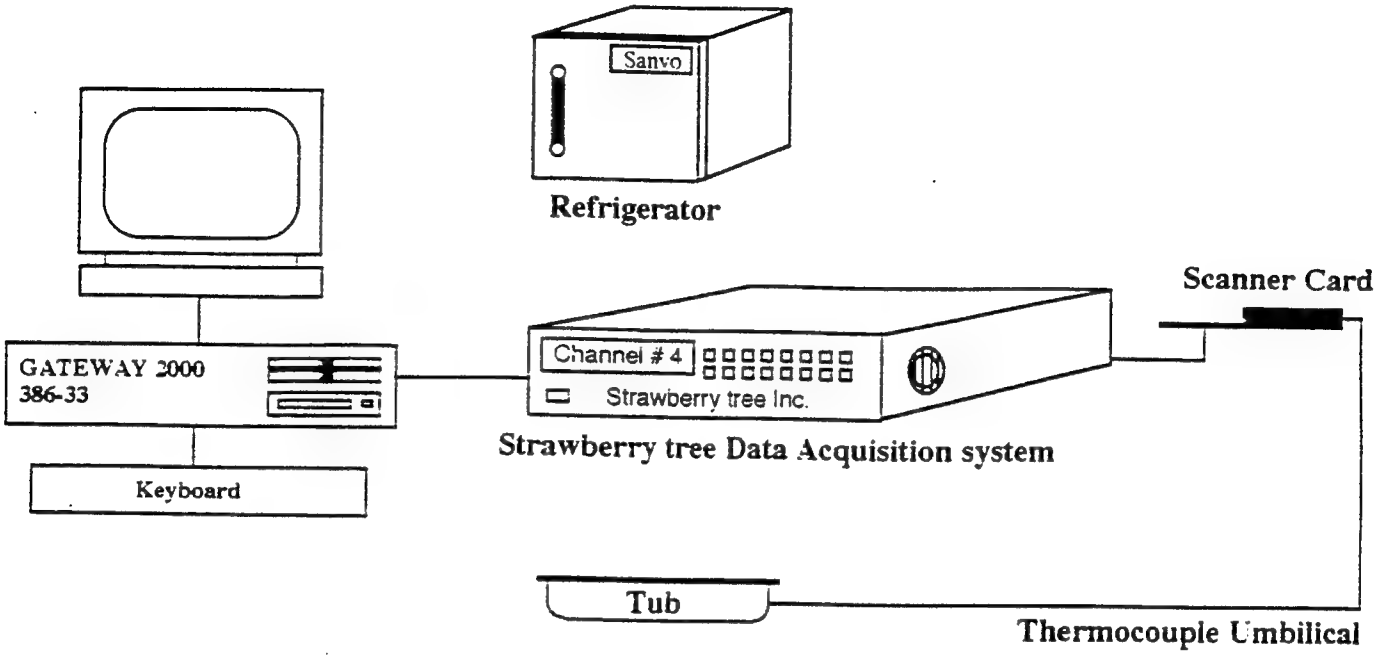

Figure 9. Test System Schematic for the Tub Experiments

14.2 Equipment Descriptions

14.2.1 Thermocouples

The thermocouple wires were all T-type or Copper-Constantan. T-type thermocouples have very good resolution for near ambient temperatures due to the low temperature range for which they were designed, 50°C (-58°F) to 190°C (374°F). To keep the thermal mass low and provide good transient characteristics, 30 and 36 gage wires were used.

14.2.2 Strawberry Tree Data Acquisition System

The Strawberry Tree system is a high speed, high precision data acquisition system. The system consists of a pair of external wiring cards for the connection of input devices, additional cards which reside in slots in the data acquisition computer, and a software interface for configuration and control of the system. The data acquisition system was borrowed from the RIT Subsonic Wind Tunnel for this research.

14.2.3 Strawberry Tree Software

The Strawberry Tree software called PC Workbench is a menu-driven icon-based software. It is used to individually configure each of the inputs and outputs of the

system. In addition it allows time-based control icons, intermediate calculation, and data logging capabilities.

14.2.4 Data Acquisition / Data Logging Computer

The computer used to run the data acquisition hardware was a Gateway 2000 386-33. This computer was also used to log the data to disk files and do the initial data analysis and reduction. The data files were managed using Quattro Pro by Borland.

14.2.5 Refrigerator

A small refrigerator was used to simulate a cold environment for some of the experiments. This provided a nearly constant temperature environment to conduct the experiments for the cold weather simulation.

14.3 Equipment Configuration

14.3.1 Strawberry Tree Hardware / Thermocouples

Each T-type thermocouple located on the surface (first three experiments) or inside the package (fourth experiment) was welded by hand, and connected to the analog input terminals of the external cards corresponding to its location on or in the tub.

14.3.2 PC Workbench Software

The PC Workbench Software was reconfigured for the 16 thermocouple inputs used in this experimentation. The configuration consists of selecting 16 analog inputs and configuring each, through the use of menus, to a T-type thermocouple input. Each input is then connected to a data-logging file. Each thermocouple input was configured to use a 17 msec. settling time to minimize the effect of signal noise. Finally each input was configured for a 10 Hz scan rate and a 15 second sampling frequency.

14.3.3 Gateway Computer

The Gateway computer was configured to support the data acquisition hardware and software. This involved the loading of certain device drivers and the setting of some basic operating parameters.

14.3.4 Refrigerator

The refrigerator was set to approximately 4°C (39°F) to provide a cold environment for some of the experimentation. Ideally it would have been set to 0°C (32°F), but due to its slight variability, 4°C (39°F) was chosen to prevent freezing.

14.4 Experimental Procedure -- Full heater

For this first set of experiments, a water-filled tub was employed. Since the tub was already sealed with the water inside, the thermocouples were located on the surface of the packaging. The thermocouple locations are shown in Figure 10. The first step in this experiment was to place a heater pad in the bottom center of the lower tub. Next the upper tub is placed in the lower tub and is clamped on three edges to prevent the loss of steam along edges which would normally be sealed. The fourth edge is left unclamped because it is adjacent to the holes which are used for water injection and package venting. The acquisition file is started and two ounces of 25°C (77°F) water are injected. The tub assembly is placed inside of the carton and the data acquisition timer is reset to zero. The experiment is allowed to run for 15 minutes during which time the "meal" heats. After fifteen minutes, the acquisition log file is stopped, and the tub is removed from the carton. The clamps are removed, the heater is discarded, and the tub halves are cleaned to remove any residue from the heater.

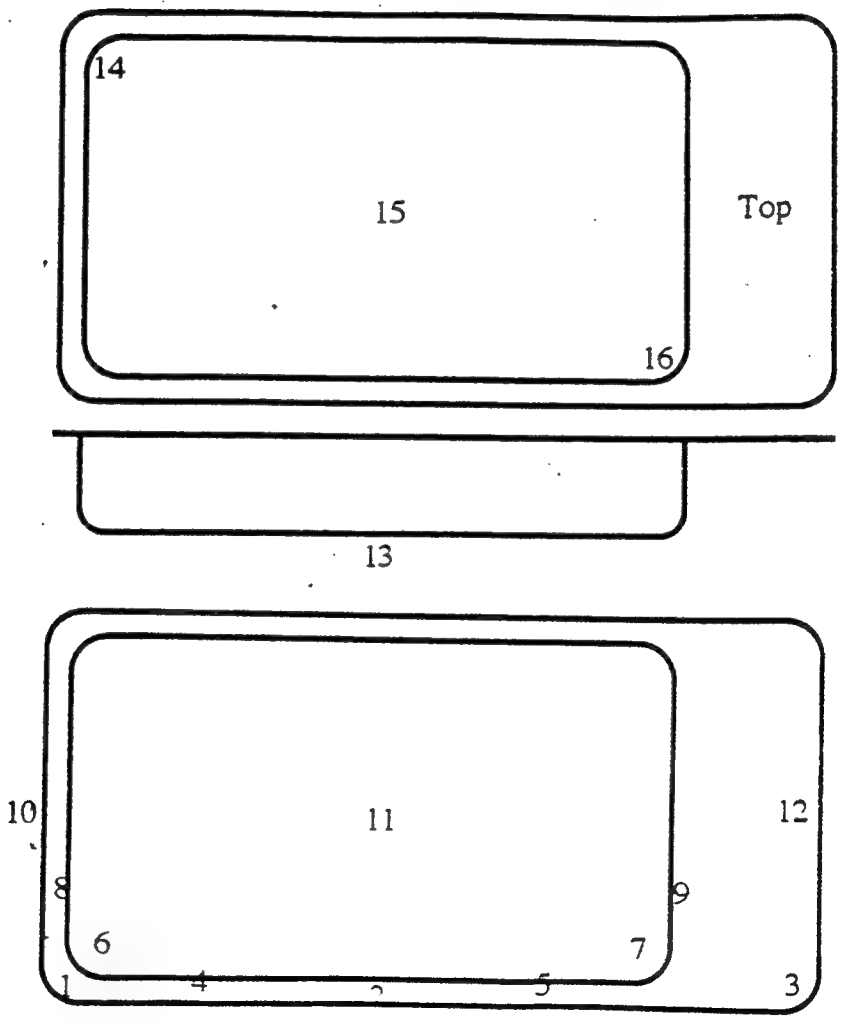

Figure 10
Water test thermocouple locations

14.5 Experimental Procedure -- Half heater

This procedure is exactly the same as in section 14.4 with one exception. For these experiments, the heater was cut in half crosswise to reduce the heater mass and area by 50 percent. To reflect the reduced heater mass, only one ounce of water was used.

14.6 Experimental Procedure -- Modified full heater

For these experiments, a full-size heater was used. The heater was modified by carving two shallow grooves into the bottom surface. One groove was put in lengthwise and the other, crosswise. This was done in an attempt to promote penetration of water to the center of the heater pad. Again, as in section 14.4, two ounces of 25°C water was used.

14.7 Experimental Procedure -- Full heater, cold environment

The tub in these experiments is filled with bentonite, a clay, which is used to simulate the thermal properties of food. Thermocouples were placed within the bentonite as shown in Figure 11. The inintial temperature for the tub, heater, bentonite, and water was approximately 4°C (39°F). The procedure for these experiments is the same as that in section 14.4, with the additional step of placing the tub in the refrigerator after the water is injected.

15.0 Experimental Results

The experimental results are summarized in Tables 5-8. The final temperatures at specific locations, (see Figures 10 & 11), are given along with percentages relative to a serving temperature of 60°C (140°F), and percentages relative to the temperatures achieved using a full heater at room temperature. The complete data files are located in Appendix E.

Table 5. -- Full Heater Results
5 Tests

Location	Surface Temperature	% Serving	% Full
6	85.83°C (185°F)	143	100
7	86.5°C (188°F)	144	100
11	75.48°C (168°F)	126	100
14	76.95°C (170°F)	128	100
15	76.4°C (169.5°F)	127	100
16	73.76°C (165°F)	123	100

Table 6. -- Half Heater Results 4 Tests			
Location	Surface Temperature	% Serving	% Full
6	59.09°C (138°F)	98.5	68.9
7	65.0°C (149°F)	108	75.1
11	69.28°C (157°F)	116	91.8
14	59.48°C (139°F)	99.1	77.3
15	60.4°C (141°F)	101	79.0
16	53.23°C (178°F)	88.7	70.8

Table 7. -- Modified Full Heater 2 Tests			
Location	Surface Temperature	% Serving	% Full
6	88.46°C (191°F)	147	103
7	88.1°C (190°F)	147	102
11	87.54°C (189.5°F)	146	116
14	79.06°C (174°F)	132	103
15	80.7°C (177°F)	135	106
16	75.36°C (167.6)	126	102

Table 8. -- Bentonite Results 5 Tests			
Location	Internal Temperature	% Serving	% Full
1	59.90°C (140°F)	99.8	69.8
3	49.78°C (122°F)	83.0	64.7
7	79.8°C (175.6°F)	133	106
9	65.9°C (150.5°F)	110	86.2
13	53.2°C (177°F)	88.7	61.6
15	49.5°C (121°F)	82.5	67.1

Additional graphical results are presented for the last case. First, a series of color figures, Figures 12a-12e, show the temperature distribution within the tub during the heating process in 3 minute increments. The plots were generated using experimental data and ANSYS for the color temperature distribution calculation. Additionally, time history plots, Figures 13a-13c, show the continuous temperature history at each location and compare the locations with common elevations.

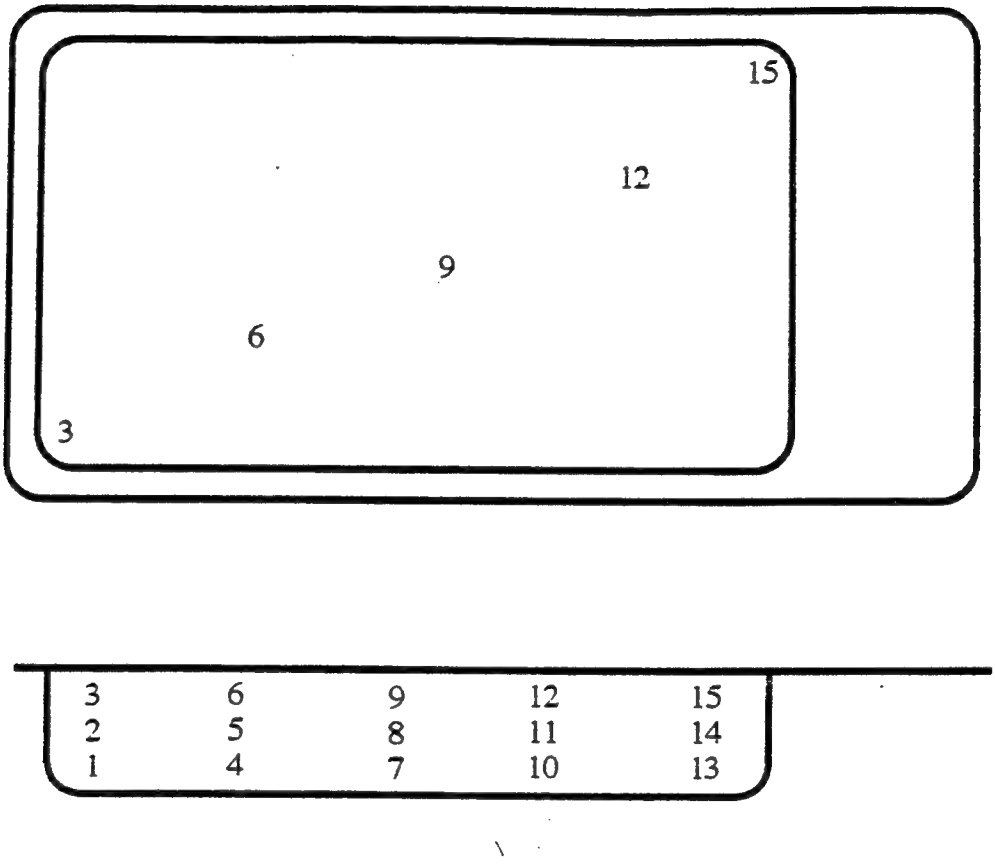

Figure 11
Bentonite thermocouple locations

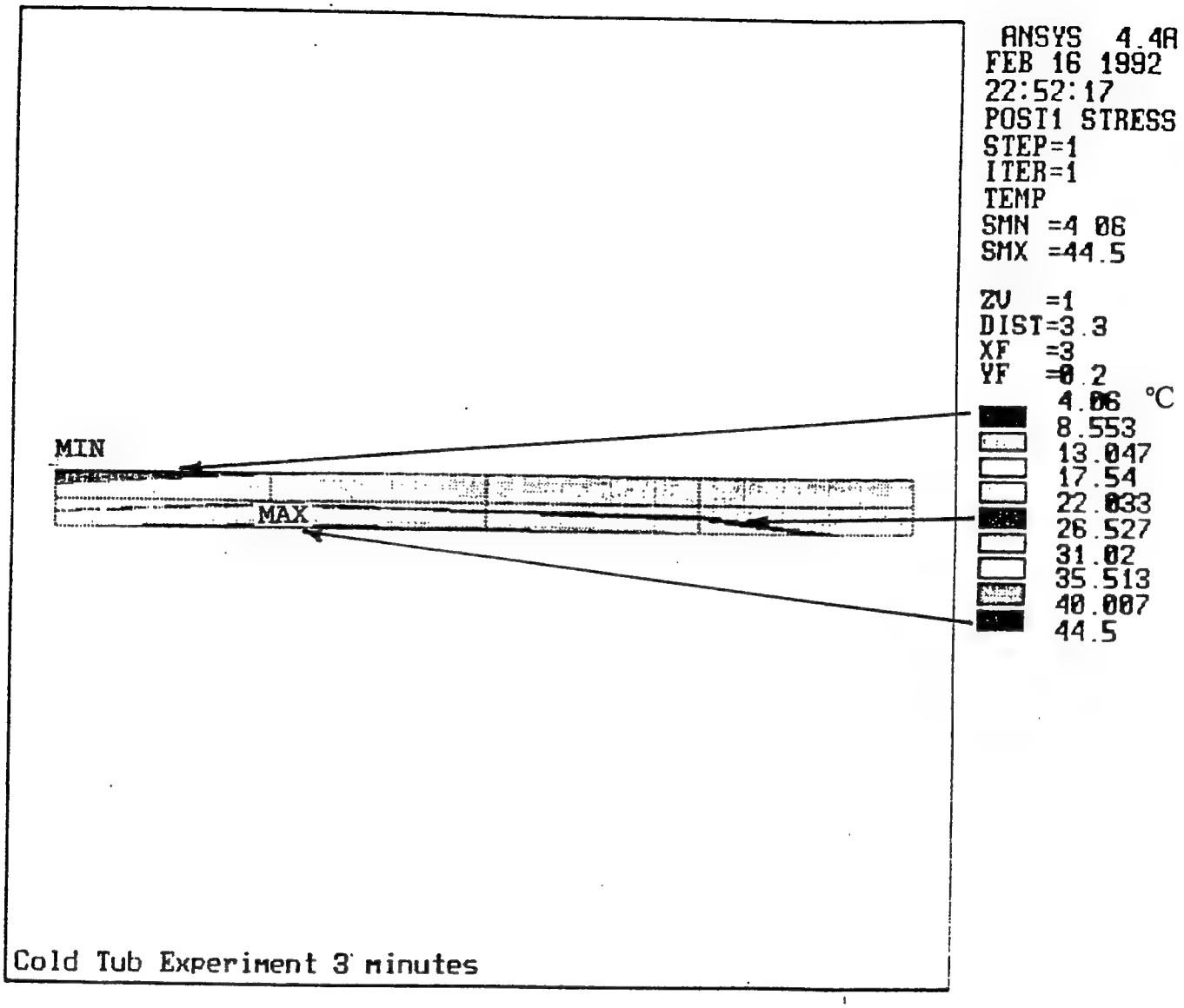

Figure 12a
Cold Tub Time Lapse Series Experimental Data Plotted Using ANSYS
Time = 3 minutes

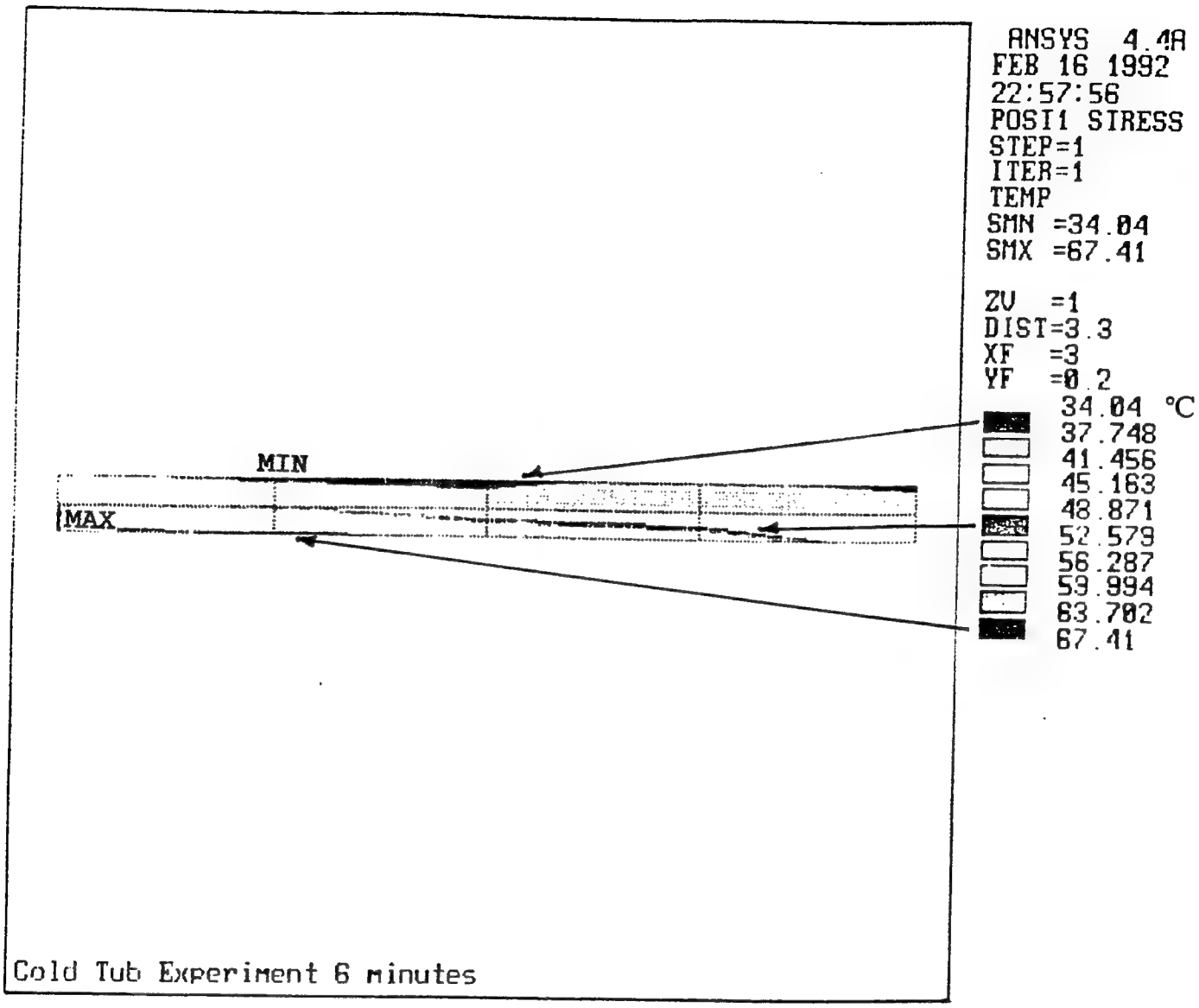

Figure 12b
Cold Tub Time Lapse Series Experimental Data Plotted Using ANSYS
Time = 6 minutes

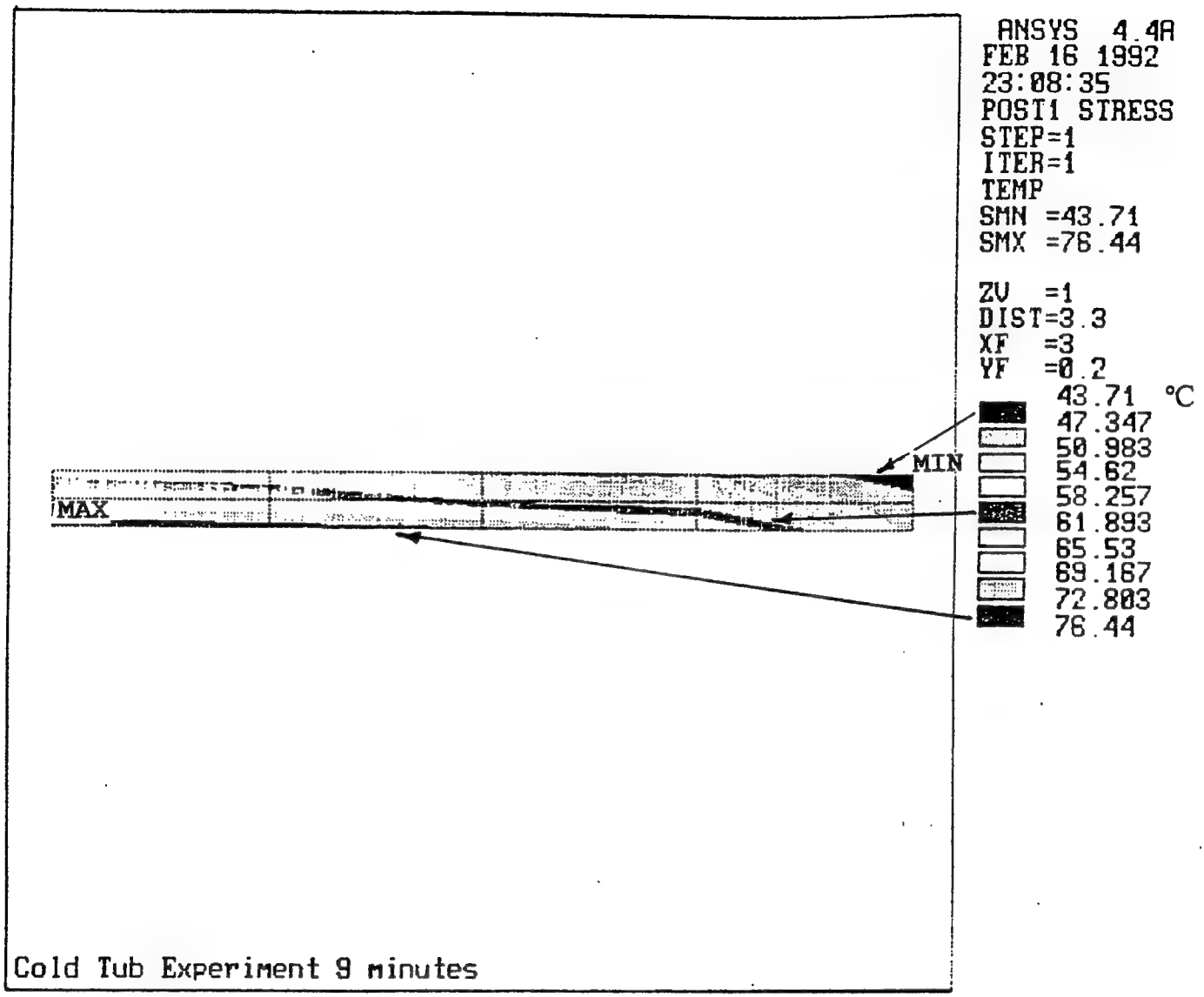

Figure 12c
Cold Tub Time Lapse Series Experimental Data Plotted Using ANSYS
Time = 9 minutes

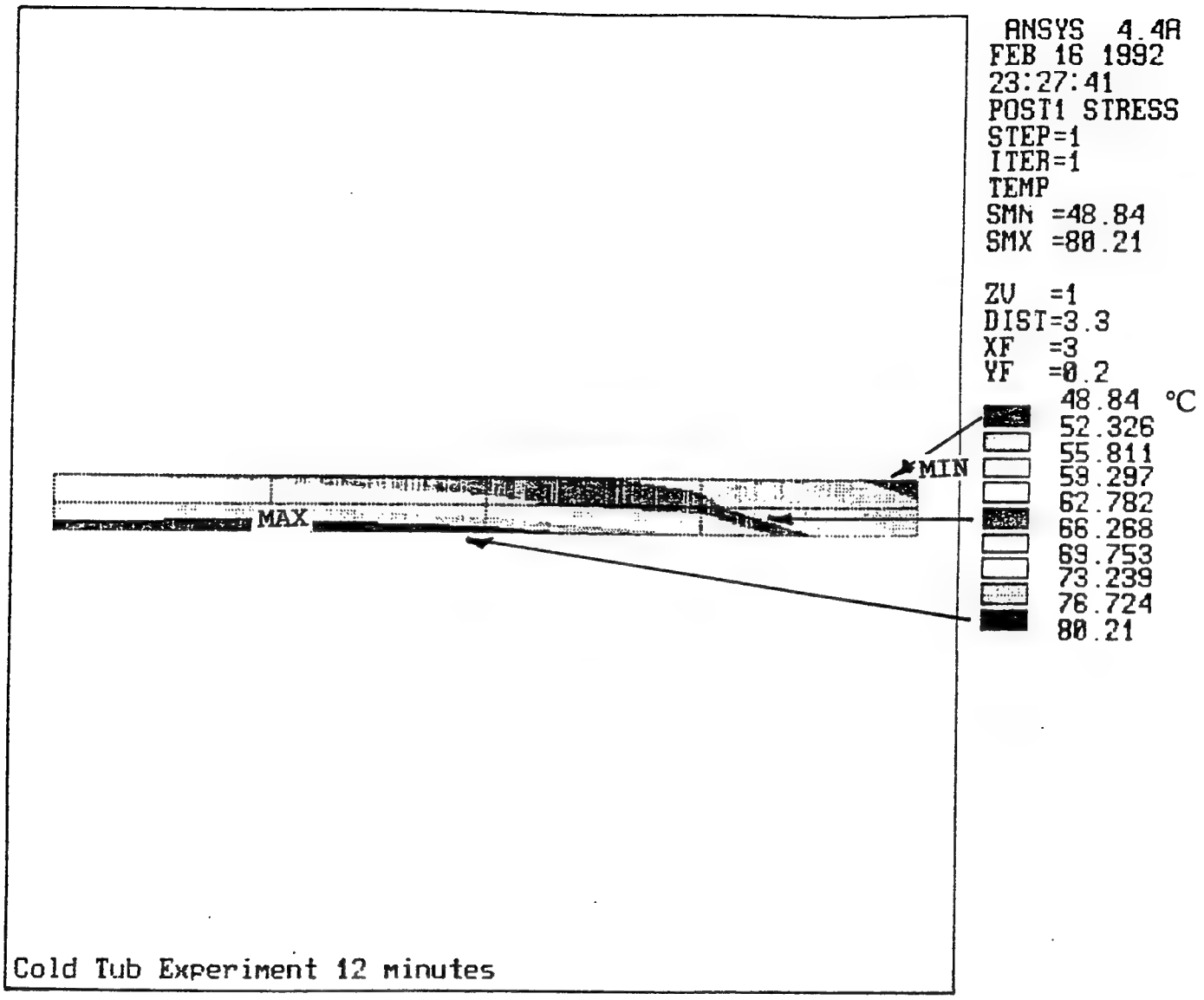

Figure 12d
Cold Tub Time Lapse Series Experimental Data Plotted Using ANSYS
Time = 12 minutes

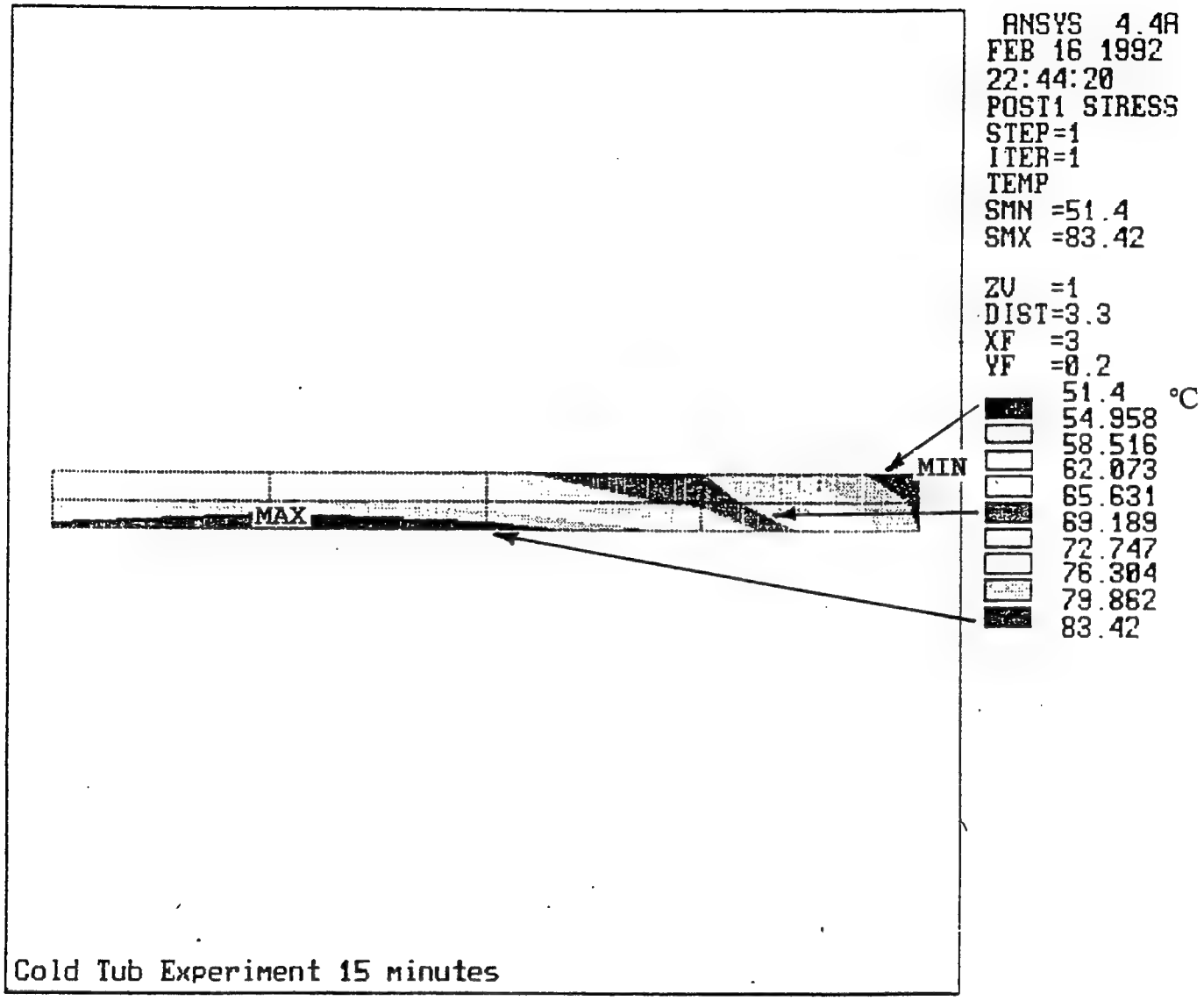

Figure 12e
Cold Tub Time Lapse Series Experimental Data Plotted Using ANSYS
Time = 15 minutes

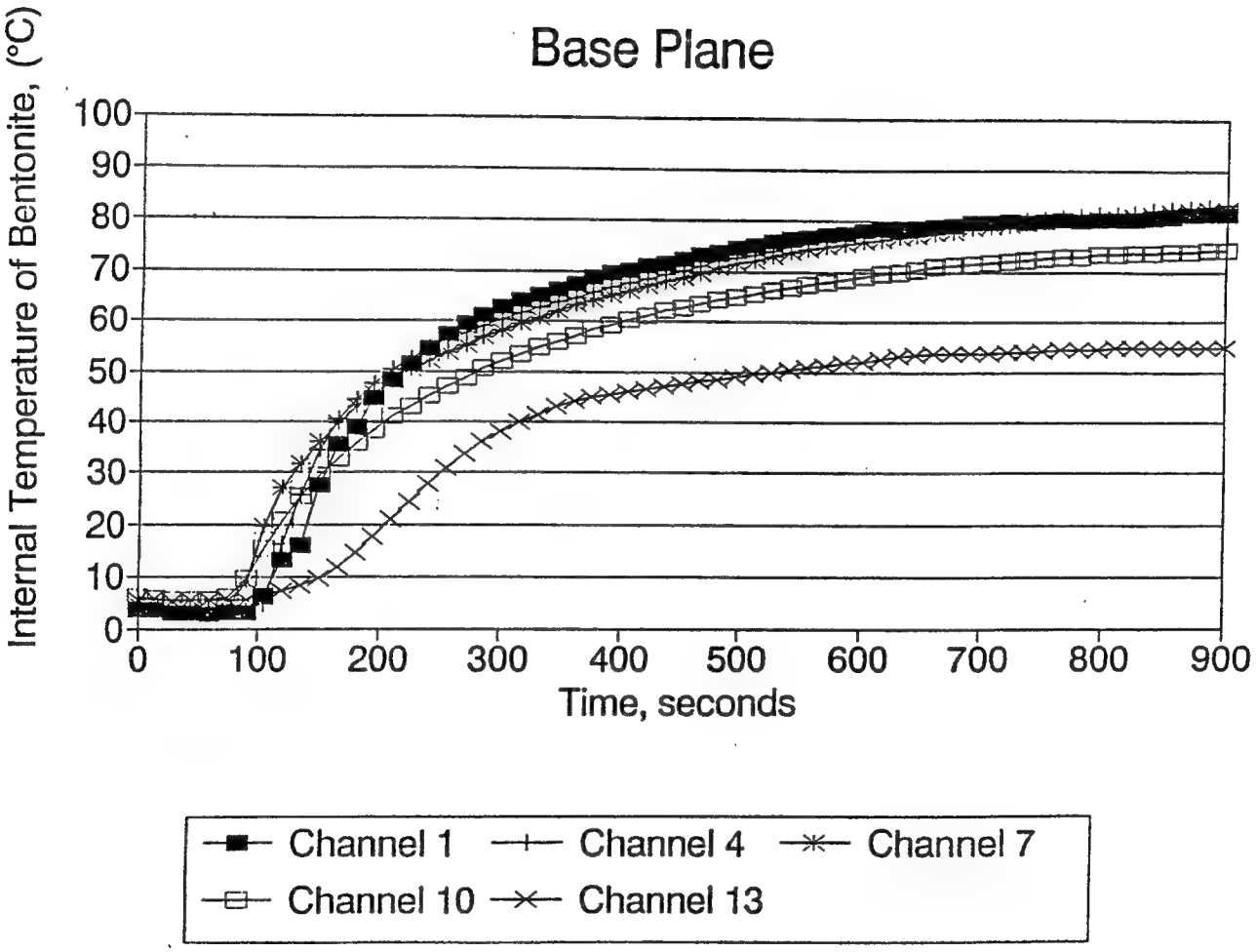

Figure 13a. Cold Tub Experiment No. 1 - Base Plane

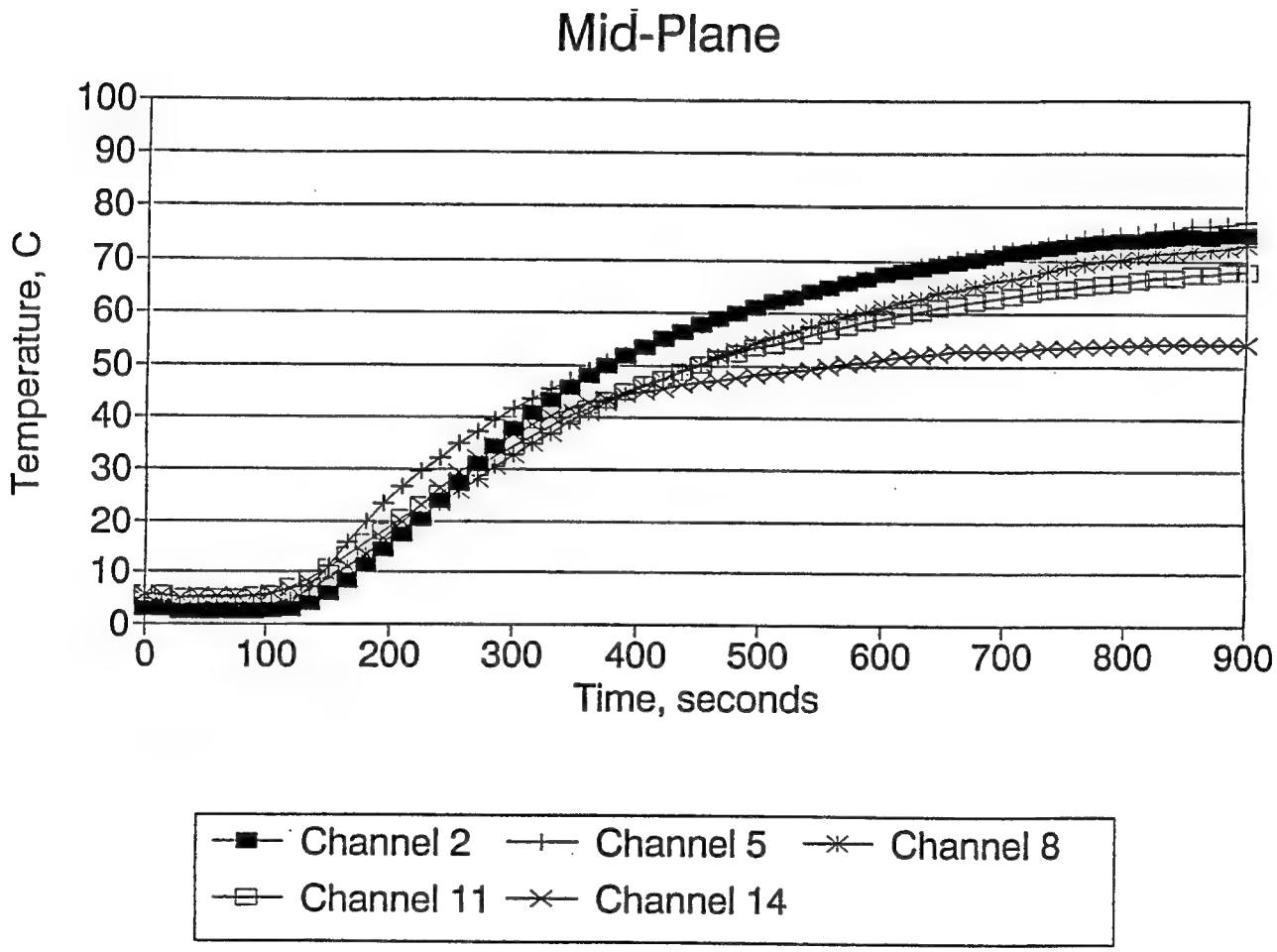

Figure 13b. Cold Tub Experiment No. 1 - Mid-Plane

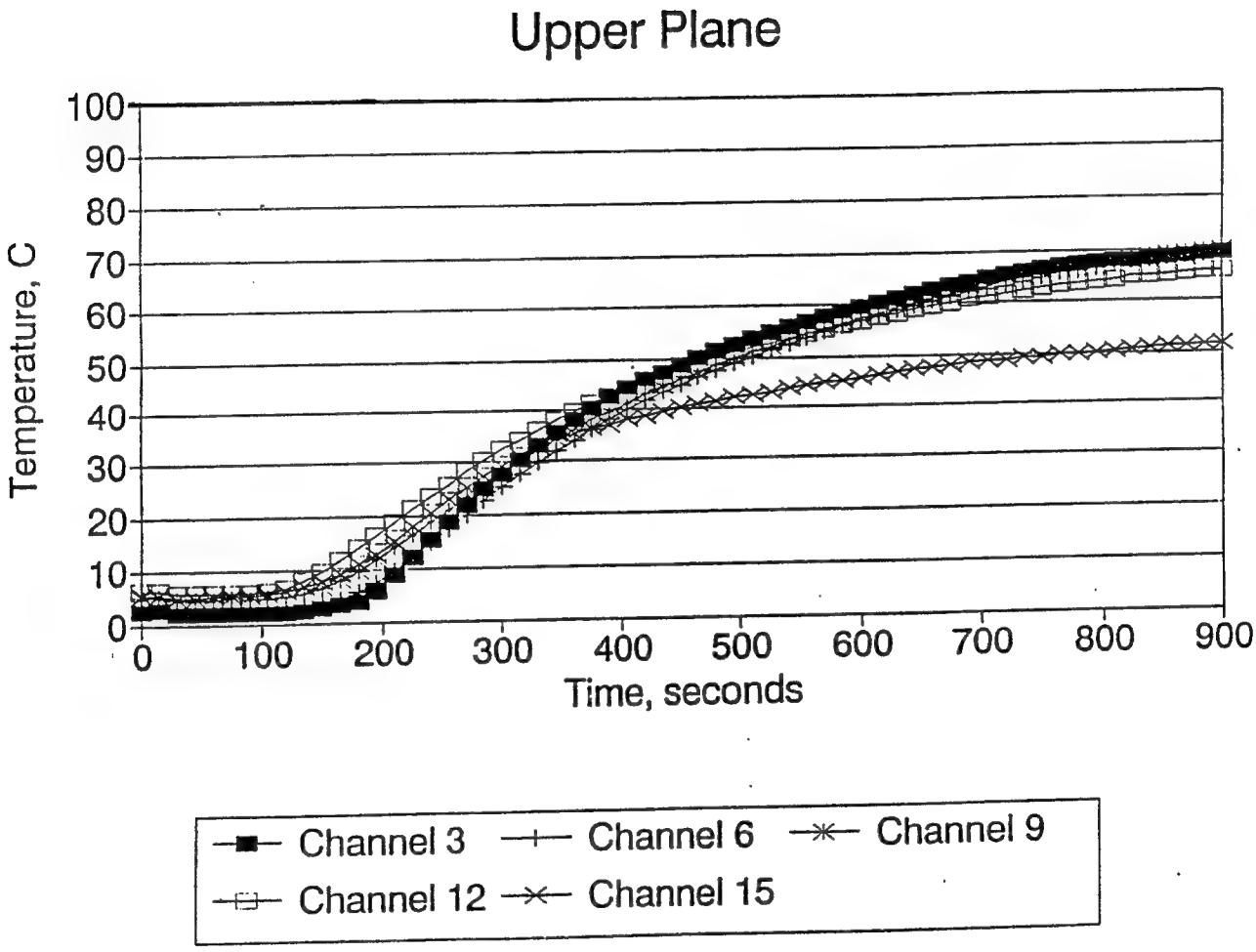

Figure 13c. Cold Tub Experiment No. 1 - Upper Plane

16.0 Interpretation of Results

Several factors combined to influence the results for the different scenarios which were considered. It is known that there is variability from one FRH to another. For this reason, all the heaters were from Lot No. 002-A, with a production date of 91-119. This minimized the variability, but did not eliminate it. It was also noticed certain areas of the heater pads didn't seem to react. This was attributed to the lack of water at these locations. This observation led to the experimentation using a modified full heater. As can be seen in Table 7, this yielded a slight improvement, although not large enough to be significant. This led to the assumption that the reaction products, steam and hydrogen gas, work to exclude the water from certain areas of the FRH by restricting flow. The latter condition provided most of the variability that was observed.

The effects of the variations were minimized by averaging each of the scenarios, using all of the tests for each scenario. This gives a value of temperature at each location, and provides reference to the serving temperature and baseline experiments which used a full heater with initial conditions at room temperature. Further, the temperatures should not be looked at as individual temperatures, but as part of a set belonging to a specific configuration.

17.0 Visual Observations

Seven additional experiments were performed using a modified upper tub. The upper tub was modified by adding a transparent window in the tub bottom to allow observation of the reaction activity. The heater reaction was videotaped. A tape is included with the report.

17.1 Baseline Test

In the first of the seven tests, a single unmodified heater was used to establish a visual baseline to compare other configurations. When the water was injected, the reaction began around the entire perimeter. Soon after the initial activity, the far end (the end opposite the water injection site) dried out and became inactive. The reaction continues, moving towards the center from approximately 50 percent of the perimeter. A large portion of the heater in the center and at the far end remained dry at the end of the test.

17.2 Two orthogonol grooves, bottom surface

The second test saw two shallow grooves carved into the bottom (away from the window) surface of the heater element, one groove in the longitudinal direction, and one groove in the transverse direction. The reaction began almost exclusively at the injection end and proceeded with a uniform front towards the far end. The reaction showed very good activity along and behind the front, but left a large portion of the heater pad unused.

17.3 Four grooves, top surface

Two grooves were placed in each direction in the FRH heater pad, longitudinal and transverse. This time the grooves were placed in the upper surface against the clear window. As in the second case, the reaction proceeded uniformly from the injection end. A small dry region remained at the end of the test.

17.4 Vented tub

For this test a small, 0.2 inch diameter hole was placed in the bottom tub opposite the injection site. The hole was placed high enough that the reaction water would not run out. Water was injected at the normal location, and the injection hole was then plugged. For this test a full unmodified heater was used. The reaction began well on the entire perimeter of the heater and then proceeded slowly towards the center, finally leaving a large dry area at the center.

17.5 Vented tub, longitudinal grooves

Test number five used the same setup as test number four, but used a modified heater. The heater had two longitudinal grooves cut in the upper surface. The reaction began immediately on the entire perimeter, but then proceeded mainly from the injection end. At the end of the test only a single, small dry location remained in one of the grooves.

17.6 Inclined tub

The tub was inclined slightly, with the injection end higher than the far end. This provided a much better initial wetting of the heater pad. The initial reaction occurred at both ends, and then the sides also began to react. Again, only a single very small dry area remained.

17.7 Inclined tub, longitudinal grooves

The last variant used was an inclined tub, combined with a pair of longitudinal grooves. The tub was again inclined with the injection end being the higher end. This test showed good initial activity on the perimeter. By the end of the test, the entire pad was showing very good activity, with no dry areas.

18.0 Experimental Conclusions

Several conclusions may be derived from the preliminary set of experiments conducted on the tub and heater geometry. Most of the conclusions point towards slight design modifications which may be desirable.

The temperature profiles were very sensitive to heater location and activity. This indicates that some care must be taken to insure that the reaction products do not restrict the flow of water to the heater pad. This may be prevented by increasing the clearance between the tubs to allow a greater flow area for the steam and hydrogen gas. Flow may also be controlled by placing grooves on the upper surface of the heater pad to promote the flow of reaction product from the reaction area. Marginal success has been achieved with this modification and it works better if the package is tipped at a slight angle. It may be possible to use this flow restriction to control heating as this information is applied in the future to meals with multiple food items.

In almost all the experiments, some water was expelled through the vent hole due to the vigorous reaction occurring within the tub. The expulsion of water indicates that the reaction rate may need to be reduced. Additionally, at the end of the fifteen minute time period used for heating, some water had not been consumed in the reaction. These two observations indicate that with better control of the water flow, the water mass could be reduced, perhaps by ten to fifteen percent.

It is suggested that further visual experimentation be undertaken to study:

(i) the effect of intermittently shaking the tub, and

(ii) the effect of inclining the tub at different angles.

This work will be undertaken in the second phase of the project.

Part D -- Numerical modelling of the TUB using ANSYS

19.0 Introduction

The ANSYS Finite Element analysis software provides exhaustive element libraries to enable adequate modelling of even complicated parts. The analysis of a structure during its design process is accomplished by the solution of partial differential equations which describe the given model. This involves the following three steps:

i. The description of the geometry, the physical characteristics and the mesh (Preprocessing).

ii. The application of Finite element analysis (Solution).

iii. The visualization and interpretation of results of the solution (Post-processing).

These three steps are quite distinct and correspond to creating, on the programming level, the three distinct modules :

i. The module to enter the data.

ii. The module to perform the analysis.

iii. The module to interpret and display the results.

19.1 Physical properties

The Element type chosen for the analysis was STIF70 which is a 3-D Isoparametric Thermal solid with 8 nodes per element and with temperature as its Degree of freedom. The materials used for the analysis were Polystyrene for the Tub material, Water and Bentonite as the equivalent for food. The ANSYS model configuration can be seen in Figure 15a and 15b. The material properties chosen for the analysis are given in the table below.

Table 9. Material properties

Materials	Thermal Conductivity Btu/hr ft°F	Density lb/ft^3	Specific Heat Btu/lb °F
Water	0.39	62.25	0.99
Polystyrene	1.08	62.43	0.35
Bentonite	1.95	67.35	1.0

19.2 Preprocessing

The model was created in 3-D in order to simulate the system better. A sample input file is seen in Appendix F. The Time step and number of iterations were set for a time period of 15 minutes. The temperature at nodes lying at the bottom of the tub was raised to about 194 °F. At Time = 0 the temperature was maintained at 77 °F. The heater was then raised to 194 °F. The temperature profiles for the various conditions are given in Figures 16,18 & 20.

19.3 Processing

The processing phase analyzes the problem and sends it to an output file that can be accessed by the post-processor. A sample output file can be seen in Appendix G. The analysis yields temperature, heat flux and stress values at each node in the model for the various time steps.

19.4 Postprocessing

A transient condition was chosen and the model was run for the present heating and the modified heating conditions. The Time history processor was used to get the plots between Temperature and Time. The plots are included in Appendix H.

19.5 ANSYS Tub model dimensions

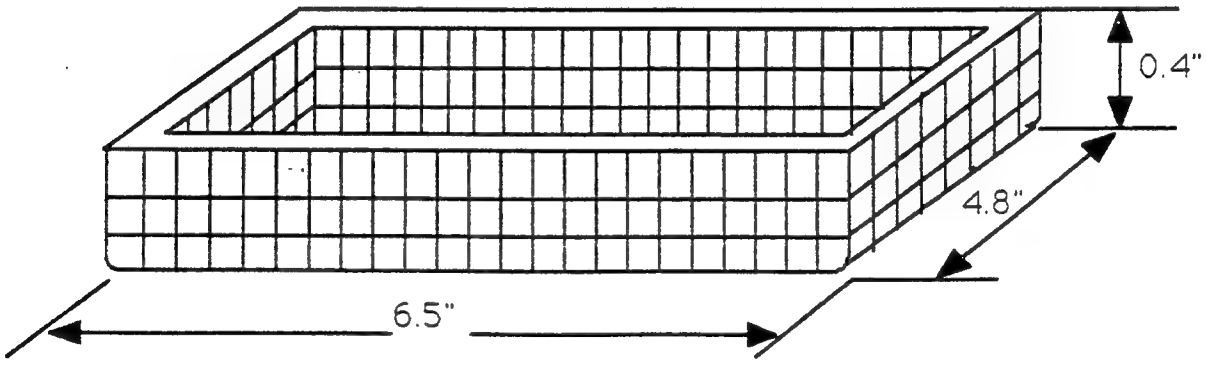

Figure 14
Top tray of the Tub

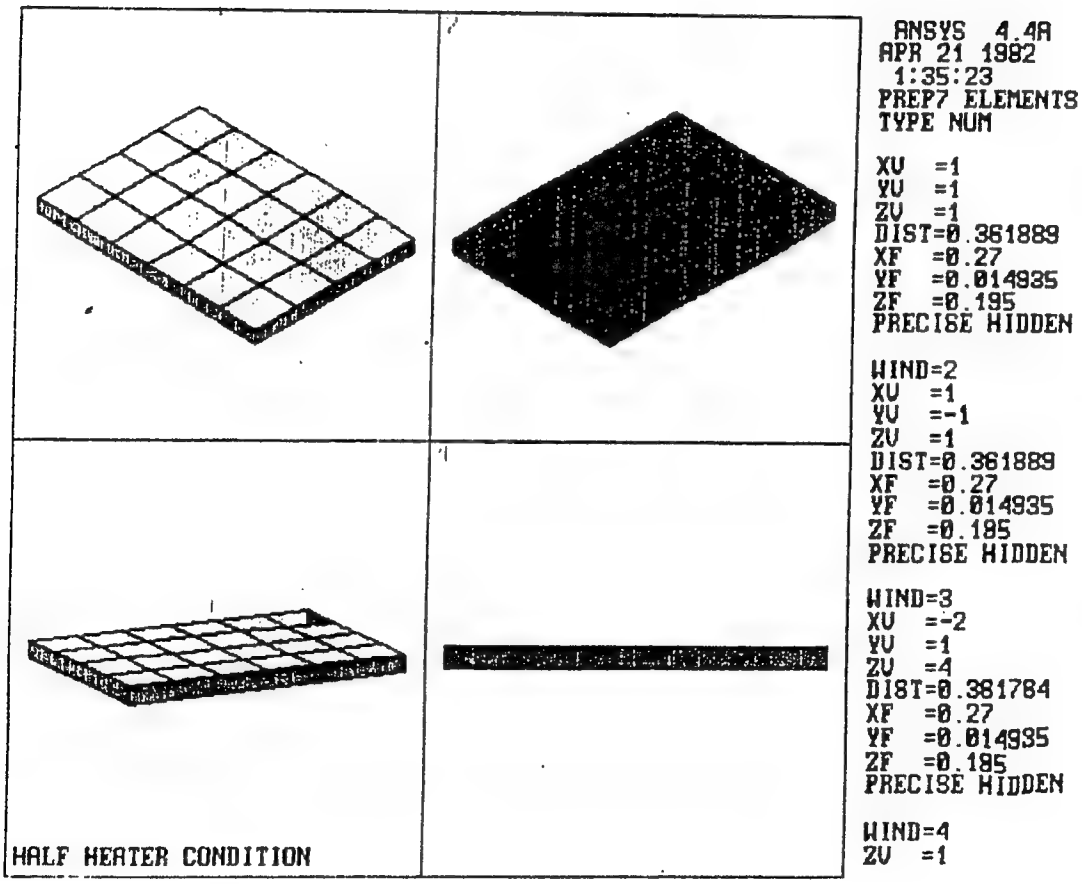

Figure 15a. ANSYS model of Tub

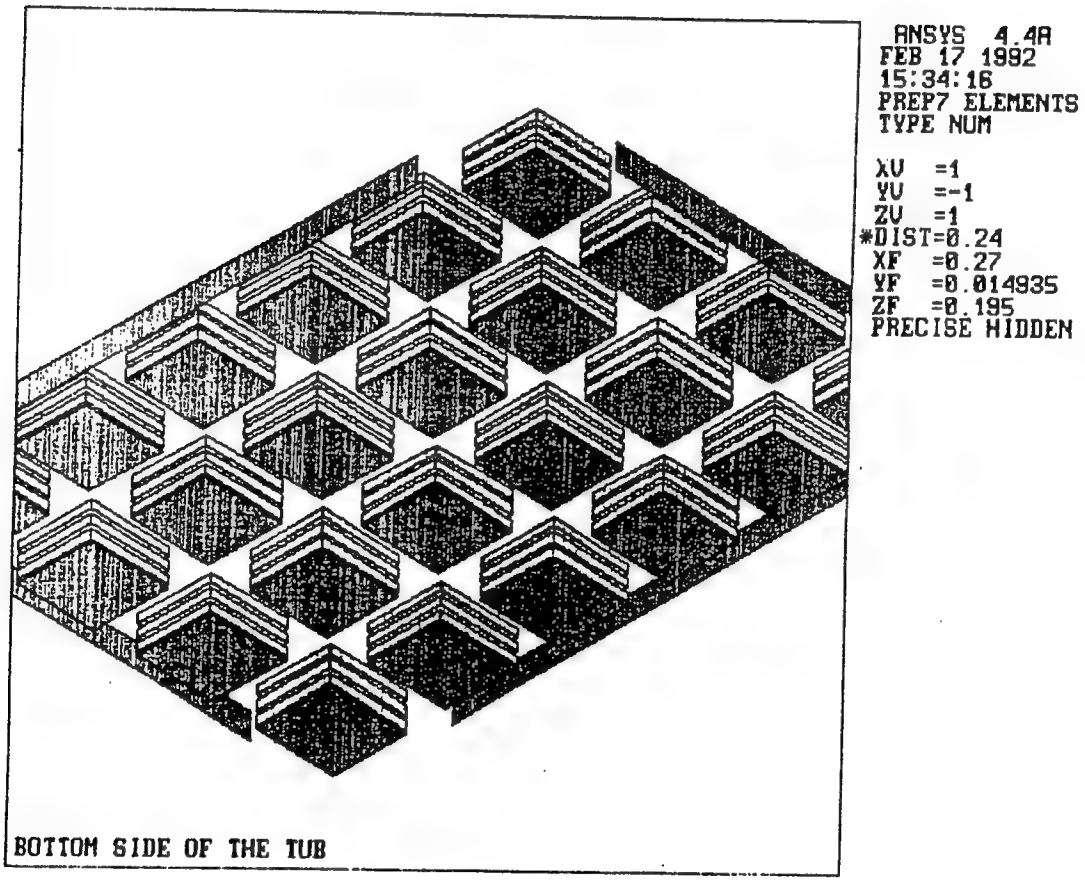

Figure 15b. Bottom side of Tub

19.6 Present heating condition

The present heating condition was modelled such that the heater was placed at the center of the top tub with the tub filled with water. The initial temperature was assumed to be at room temperature of 25°C (77°F) and all the nodes in the tub were maintained at that temperature. At Time T>0 the heater was heated and was raised to 194°F. Figure 16 shows the temperature profiles for the present heating condition.

19.7 Half heater configuration

The half heater was done by cutting the heater into two halves and using one of them as the heat source. This scenario was simulated using ANSYS by reducing the area of heat supplied to one half the previous condition. The temperature profiles for this condition can be seen in Figure 18 and the thermal flux vector plots in Figure 19. The results of the ANSYS results for this condition reveal certain deviations from the experimental results and the reason for this is attributed to the positional deviations in the nodes that represent the area of the half heater.

19.8 Cold tub heating condition

The modified heating was done by initially maintaining the whole system at a constant temperature of 39.2 °F. The simulated temperature rise was specified at the bottom of the tub to 194 °F. The temperature rise at the various nodes corresponded well with the experimental data. Figure 20 represents the Temperature profiles for this condition at the end of 15 minutes.

20.0 Comparison of Experimental results with ANSYS results

Tables 10a-10c show a comparison between the experimental values of temperatures at specific thermocouple locations. Tables 10a and 10b present the transient data for water in the tub. For this case the thermocouple location numbers can be seen from Fig. 10. Table 10c presents the transient Bentonite data with thermocouple location numbers given in Fig. 11. Node #15 is the driving node at the heater surface. Its temperature is assumed to rise at the instant the reaction starts.

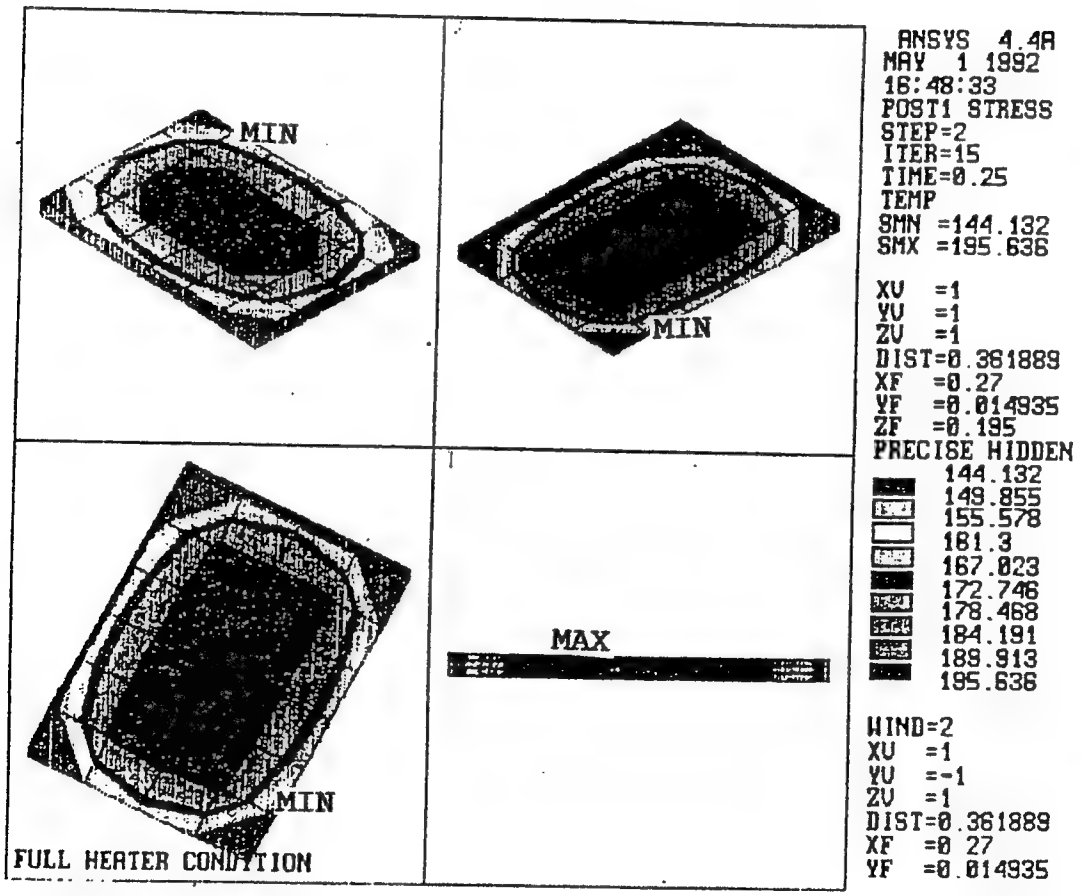

Figure 16. Temperature profile for the present heating condition

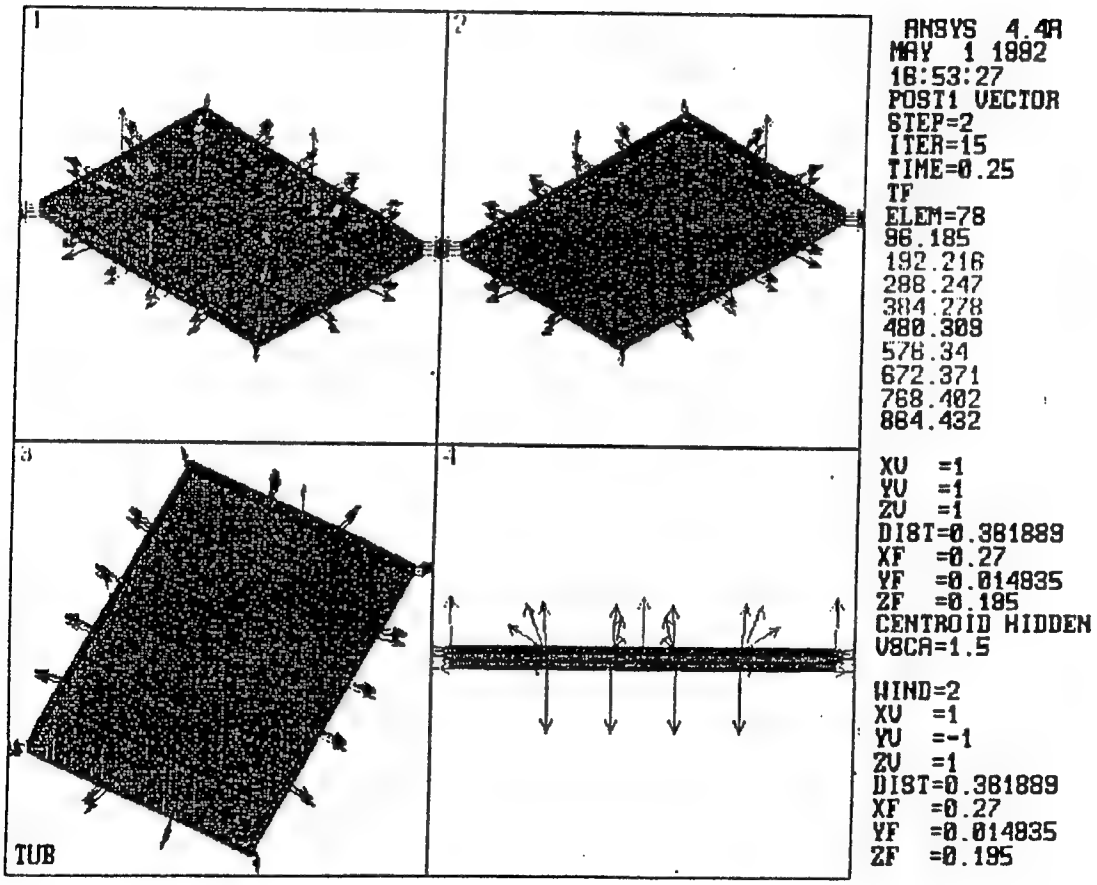

Figure 17. Thermal flux vectors for the present heating condition

Table 10a

Comparision of ANSYS predictions with Experimental data for water with a full heater.

Time (min)	Thermocouple location number # 15 °F	Corresponding ANSYS node # 125 °F
0	79.23	77
1.5	97.61	92.2
3	106.3	102.3
4.5	128.2	111.4
6	139.4	119.2
7.5	142.3	128
9	151.1	139.5
10.5	158	143
12	162.9	153.6
13.5	169	160.1
15	170.1	162.5

Time (min)	Thermocouple location number # 11 °F	Corresponding ANSYS node # 7 °F
0	79.3	77
1.5	197.4	194
3	195.4	194
4.5	200	194
6	199.5	194
7.5	199.7	194
9	197.4	194
10.5	197.5	194
12	192.2	194
13.5	189.5	194
15	186.4	194

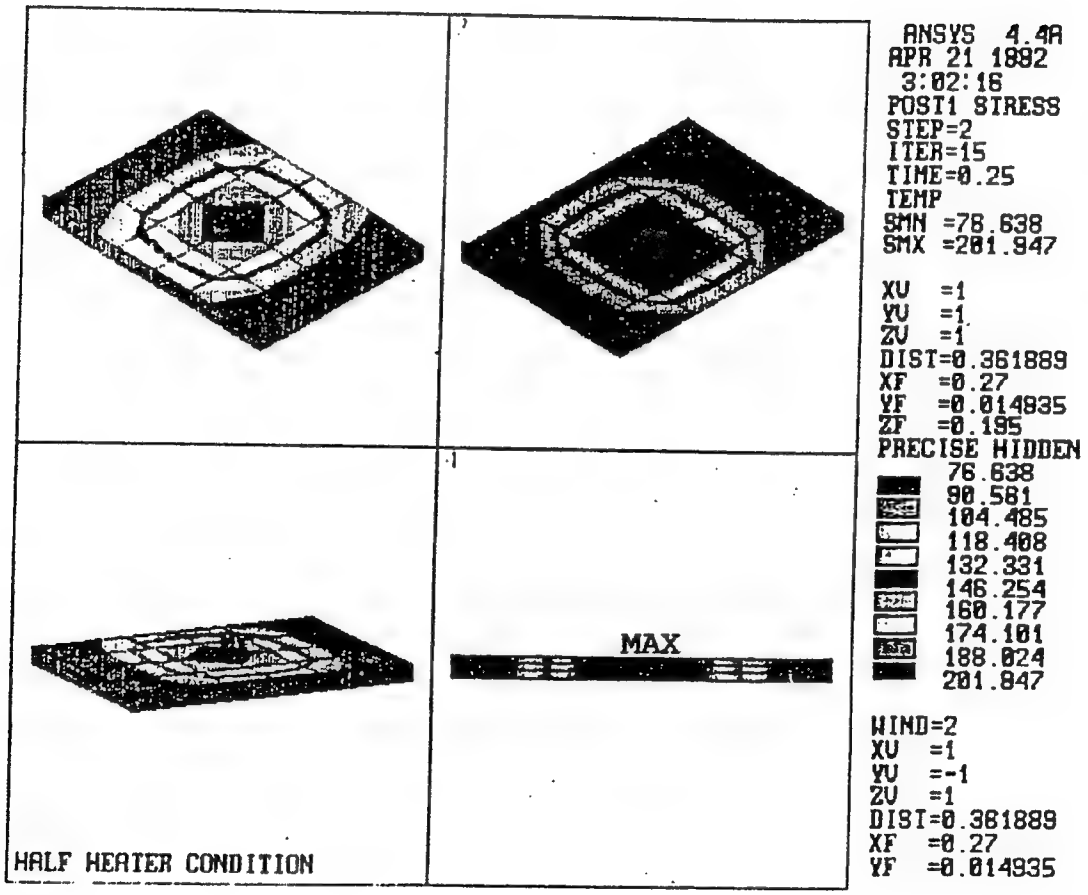

Figure 18. Temperature profiles for a half heater condition

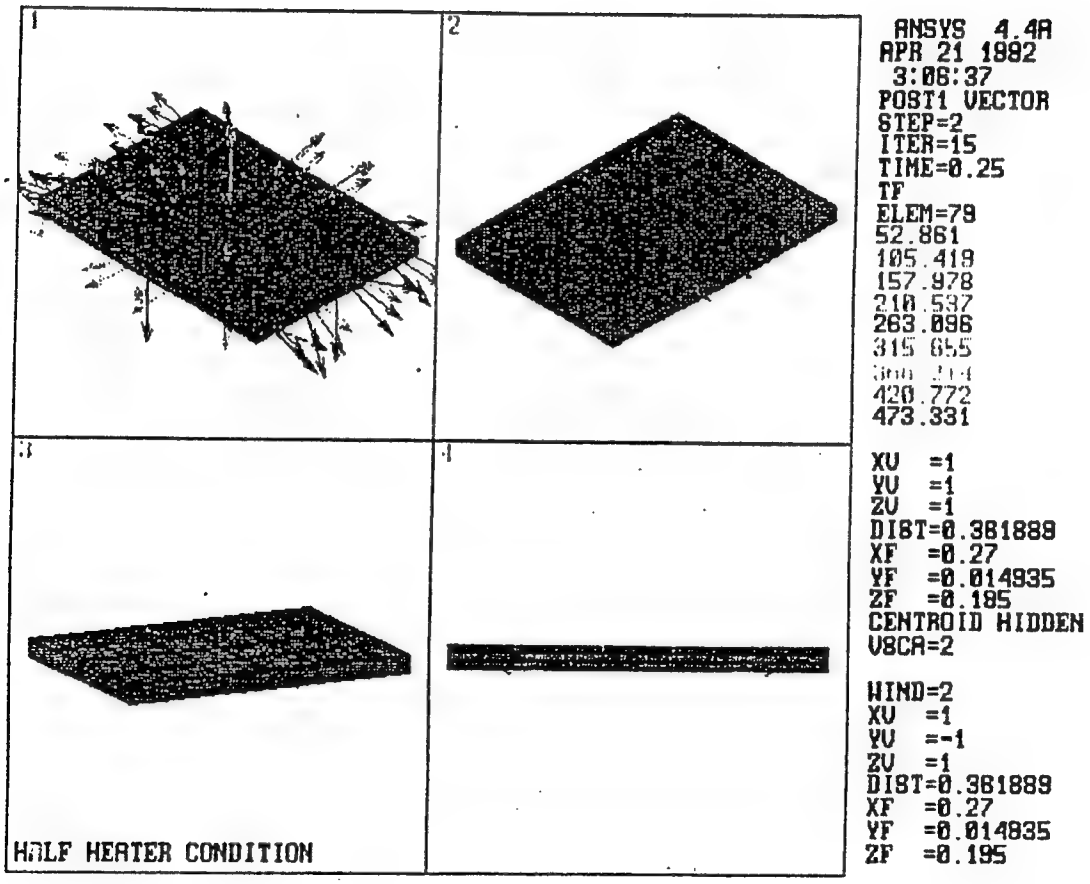

Figure 19. Thermal flux vectors for a half heater condition

Table 10b

Comparisions of ANSYS predictions with Experimental data for water with a half heater.

Time (min)	Thermocouple location number # 15 °F	Corresponding ANSYS node # 89 °F
0	79.4	77
1.5	92.9	93.2
3	107.4	119.4
4.5	117.6	137.5
6	125.2	151.4
7.5	130.6	160.1
9	134.8	166.7
10.5	137.7	173.2
12	139.8	177.8
13.5	141	180.3
15	141.6	181.7

Time (min)	Thermocouple location number # 11 °F	Cooresponding ANSYS node # 18 °F
0	80.4	77
1.5	199.4	194
3	196.6	194
4.5	187.8	194
6	182.4	194
7.5	177	194
9	172.5	194
10.5	168.3	194
12	164.4	194
13.5	161.24	194
15	158.23	194

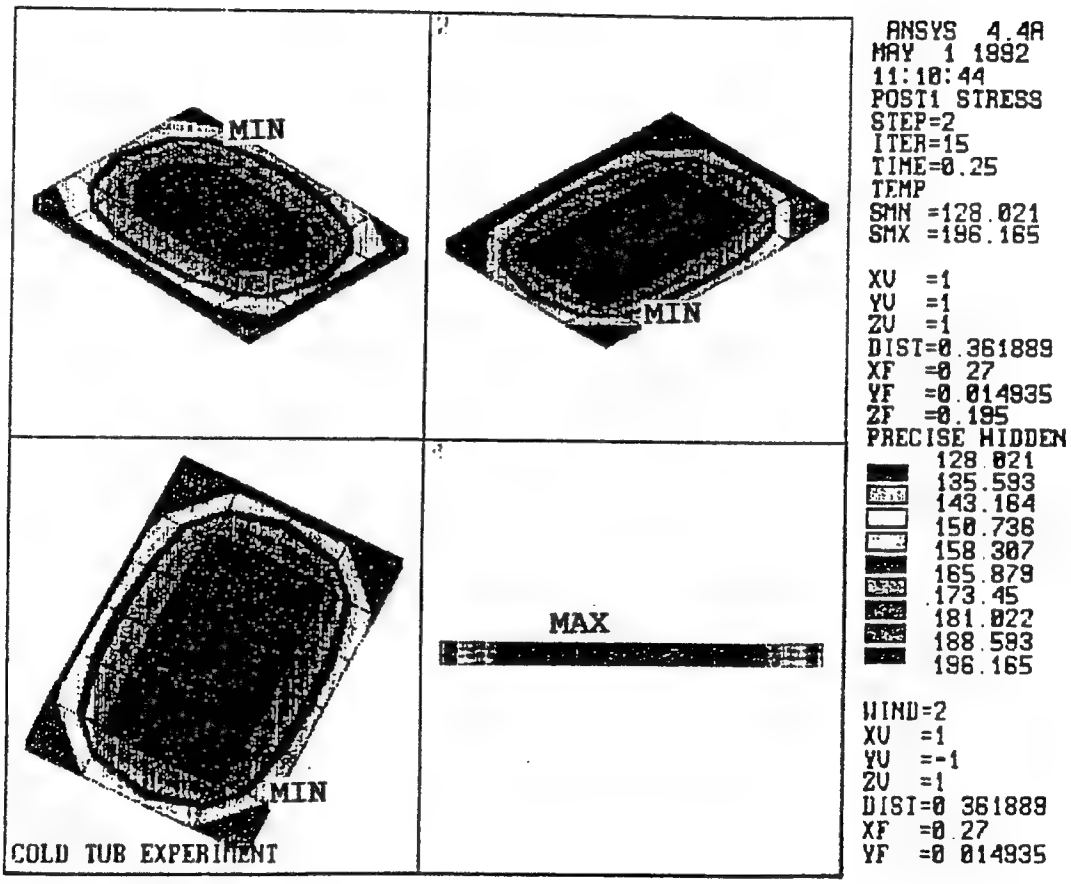

Figure 20. Temperature profile for the cold tub heating condition

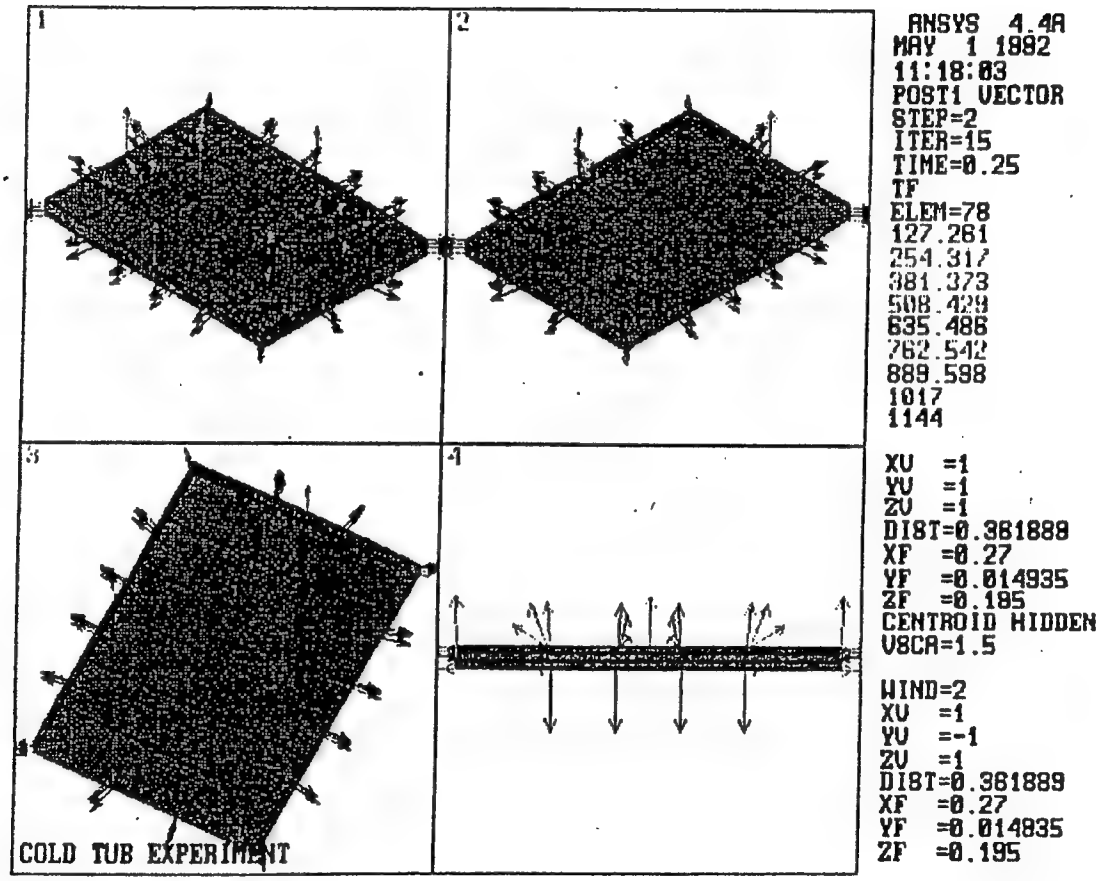

Figure 21. Thermal flux vectors for a half heater condition

Table 10c

Comparision of ANSYS predictions with Experimental data for bentonite with a full heater.

Time (min)	Thermocouple location number # 9 °F	Corresponding ANSYS node # 125 °F
0	41.5	39.2
1.5	40.7	59.4
3	49.6	71
4.5	74.2	82.4
6	96.8	98.7
7.5	114.6	106.1
9	129.9	120
10.5	138.6	131.3
12	147.2	139.8
13.5	153.8	143.2
15	157.6	156.6

Time (min)	Thermocouple location number # 7 °F	Corresponding ANSYS node # 89 °F
0	40.6	39.2
1.5	109.3	104.7
3	131.2	168.5
4.5	145.7	182.3
6	155.9	185
7.5	164.4	187.4
9	170	188.6
10.5	177.2	187.9
12	179.3	188.1
13.5	180.3	190
15	182.1	192.3

21.0 Summary of Tub Research

The tub geometry was investigated in detail. Experiments were conducted to obtain the transient heat transfer characteristics using water and bentonite as the tub medium. Three heater configurations were employed. These were: full heater, half-sized heater and grooved heaters. Some experiments were also conducted to find the effect of initial tub temperature on the performance.

The numerical analysis was done using the ANSYS software on a personal computer. The same conditions employed in the experiments were used in modelling the tub performance during transient heating.

The experimental and numerical results have been found to agree quite well for most cases. The largest discrepancy was noted for the half heater conditions. The heaters could not be cut exactly in half and its position could not be controlled accurately to correspond to the actual nodal positions. Water distribution and reaction rates for half heaters may also be different.

A visual study was also conducted to see the propagation of water in the heater. The results were recorded on a VHS tape. This study indicated that the center portion of the heater was starved throughout the heating period, and remained as a dry patch. Proper irrigation of water, either using grooves or recommending intermediate shaking of the tub, are additional possibilities that need to be explored. Further work on this aspect will be undertaken during the Phase II of the project.

In general, the tub results indicate that the present heaters are definitely adequate for achieving the desired heating characteristics. Further optimization is possible and additional work is being planned to study the effect of heater size, shape and operating conditions on its performance.

22.0 Summary of Phase I Research

The project on the "Thermal Analysis and Development of Ration Packaging for Efficient Heating With Flameless Electrochemical Heaters" was started at RIT under the contract from the US Army Natick Research, Development and Engineering Center. The investigation was conducted on two ration packaging configurations, MRE and Tub Packaging.

The research on MRE indicated that it was possible to model the transient heating using ANSYS software package. The experimental results were in agreement with the numerical results. As a result of this work, it was possible to study the effects of different operating conditions on the thermal performance of MRE's. Secondary effects of insulation, steam distribution and initial temperatures were also explored.

The work on the tub was carried out on similar lines to the MRE's. The agreement between the experimental work and the numerical predictions were good. The research clearly identified areas where further efforts are needed. These include the investigation of half heaters, grooves in the heater and shaking the tub during operating cycle. The visual study indicated the need for irrigating water efficiently over the entire heater, especially in the central region.

This document reports research undertaken at the U.S. Army Natick Research, Development and Engineering Center and has been assigned No. NATICK/TR-95/009 in the series of reports approved for publication.

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LIST OF REFERENCES

1. Kandlikar, S. G., 1990. Thermal Optimization of Flameless Ration Heaters, Food Engineering Directorate, US Army Natick RD&E Center, Natick, MA.

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APPENDIX A

EXPERIMENTAL DATA FOR MREs

Appendix A

Experimental Data for MREs

Experiment No. 1
Filename MRE01.DAT

Initial Temperature of MRE, FRH, packaging, and surroundings -- 25.9°C
Initial Temperature of water -- 30.0°C

Mass of FRH -- 30.0 grams
Mass of water -- 59.2 grams

Average temperature after 300 seconds -- 55.5°C
Change in temperature, ΔT -- 29.6°C

Table A-1, **MRE01.DAT -- Thermocouple Temperatures**

Time	Ch 2	Ch 3	Ch 4	Ch 5	Ch 6	Ch 7	Ch 8	Ch 9	Ch 10
0:00	38.2	27.4	27.2	27.8	61.6	91.3	38.1	31.2	28.2
0:04	53.0	27.7	62.4	27.8	96.5	95.3	44.7	37.9	29.4
0:19	77.9	45.2	79.4	27.6	97.1	79.4	51.8	59.5	77.6
0:34	74.4	51.8	80.0	27.6	97.7	88.6	61.2	75.0	80.0
0:49	73.8	56.6	80.7	27.9	98.0	95.5	59.1	78.0	79.8
1:04	74.8	61.2	81.5	28.3	98.4	94.5	66.3	82.7	79.8
1:19	75.5	64.7	82.4	29.5	95.5	95.8	63.0	83.7	77.2
1:34	76.8	67.1	79.9	29.5	94.4	95.3	61.1	84.9	77.2
1:49	78.2	68.8	78.2	29.9	94.1	95.3	64.2	85.0	76.7
2:04	79.9	70.7	77.5	30.2	93.7	95.5	61.1	85.0	78.6
2:19	81.2	72.6	78.1	30.3	94.0	95.5	60.3	82.5	77.5
2:34	82.3	74.4	77.4	31.3	93.8	95.4	61.0	82.2	76.9
2:49	83.4	75.9	77.8	30.8	93.8	95.5	63.7	84.4	76.7
3:04	84.2	77.3	78.0	31.0	93.9	95.0	61.8	84.3	75.3
3:19	84.8	79.5	77.6	31.3	93.8	95.1	68.1	84.1	79.0
3:34	85.6	81.2	77.8	31.4	94.0	94.4	63.2	83.8	77.3
3:49	86.2	82.4	78.3	31.5	93.9	94.4	64.6	83.7	77.2
4:04	86.8	83.5	78.5	32.1	94.1	94.7	66.2	84.3	78.1
4:19	87.3	84.5	78.7	32.3	94.3	94.6	67.6	84.5	76.4
4:34	87.7	85.3	78.5	32.6	94.1	94.8	68.8	84.5	76.3
4:49	88.2	86.0	78.5	32.8	94.3	94.8	71.0	85.0	77.4
5:04	88.7	86.6	79.4	33.6	94.3	94.9	72.4	84.5	75.5

Experiment No. 2
Filename MRE02.DAT

Initial Temperature of MRE, FRH, packaging, and surroundings -- 25.0°C
Initial Temperature of water -- 30.0°C

Mass of FRH -- 31.4 grams
Mass of water -- 59.2 grams

Average temperature after 300 seconds -- 55.0°C
Change in temperature, ΔT -- 30.0°C

Table A-2. MRE02.DAT -- Thermocouple Temperatures

Time	Ch 2	Ch 3	Ch 4	Ch 5	Ch 6	Ch 7	Ch 8	Ch 9	Ch 10
0:00	50.0	93.8	59.6	69.7	32.6	84.2	28.9	49.9	54.6
0:04	48.3	94.2	72.0	71.5	37.9	66.2	29.5	58.3	67.1
0:19	47.8	94.8	72.9	81.2	44.9	60.5	29.3	71.5	74.1
0:34	47.7	95.3	74.4	81.6	49.5	61.0	28.5	75.6	74.7
0:49	48.6	96.5	76.3	78.7	55.5	62.2	28.2	78.3	73.8
1:04	49.4	97.4	77.7	77.6	59.6	63.3	27.8	81.3	72.6
1:19	51.1	96.8	78.9	78.5	62.9	65.5	27.4	80.5	75.7
1:34	53.7	97.1	80.0	79.8	67.7	65.3	27.2	79.8	73.2
1:49	56.6	96.4	81.1	80.9	71.5	65.7	27.1	80.2	74.0
2:04	59.3	96.7	81.6	82.0	73.8	66.2	27.2	81.3	77.9
2:19	61.8	97.2	82.4	83.2	75.9	65.9	27.3	81.9	71.1
2:34	64.3	97.0	83.1	84.9	77.5	66.1	27.4	82.4	73.5
2:49	66.7	96.7	83.6	85.1	78.6	65.8	27.6	82.5	75.7
3:04	68.8	96.6	84.3	85.8	80.0	66.1	27.8	83.1	81.2
3:19	70.9	96.5	84.8	86.7	81.0	66.4	28.1	83.7	75.1
3:34	72.9	96.2	85.3	87.1	81.9	66.7	28.5	84.1	72.8
3:49	74.6	96.1	85.7	87.1	82.7	67.2	28.8	83.5	74.7
4:04	76.2	96.0	86.1	87.9	83.2	67.9	29.2	83.0	71.8
4:19	77.6	96.0	86.6	87.9	83.2	68.2	29.6	81.8	80.0
4:34	79.0	96.0	87.1	88.1	83.8	68.7	30.0	83.8	76.7
4:49	80.3	95.9	87.5	88.2	84.0	69.0	30.4	84.2	76.0
5:04	81.4	95.8	87.8	88.3	84.2	69.5	30.9	82.9	75.6

Experiment No. 3
Filename MRE03.DAT

Initial Temperature of MRE, FRH, packaging, and surroundings -- 25.5°C
Initial Temperature of water -- 30.0°C

Mass of FRH -- 30.3 grams
Mass of water -- 59.2 grams

Average temperature after 300 seconds -- 53.5°C
Change in temperature, ΔT -- 28.0°C

Table A-3. MRE03.DAT -- Thermocouple Temperatures

Time	Ch 2	Ch 3	Ch 4	Ch 5	Ch 6	Ch 7	Ch 8	Ch 9	Ch 10
0:00	26.8	35.2	76.1	31.8	26.6	26.4	28.0	30.4	28.3
0:04	61.5	53.6	95.9	36.7	26.6	26.6	27.8	49.4	29.6
0:19	74.1	70.7	89.0	39.1	36.2	65.2	35.0	67.5	69.1
0:34	72.4	94.4	88.3	43.5	44.0	72.4	40.6	71.8	74.3
0:49	74.0	89.8	88.8	49.0	51.6	76.8	35.0	73.9	75.7
1:04	75.0	89.3	89.3	51.0	58.5	79.1	36.6	74.3	76.6
1:19	75.5	89.5	90.2	52.7	63.6	79.2	38.9	76.8	73.0
1:34	76.6	91.6	89.9	53.9	67.5	80.5	40.3	80.3	72.6
1:49	77.8	90.0	90.1	55.1	70.6	80.4	39.8	79.1	77.3
2:04	78.7	91.4	90.7	56.4	73.1	81.7	39.4	80.1	76.5
2:19	79.3	92.2	93.4	57.4	75.0	82.0	38.7	80.8	72.9
2:34	80.1	93.2	93.5	58.2	76.7	81.9	38.3	81.1	76.4
2:49	81.2	93.3	93.8	58.1	78.0	81.0	37.9	83.2	75.7
3:04	81.9	93.5	93.7	57.9	79.1	84.3	38.2	83.7	75.1
3:19	82.8	93.5	93.6	58.0	80.2	84.6	37.4	84.5	75.9
3:34	83.4	93.7	93.1	59.2	81.2	84.5	37.1	84.0	75.1
3:49	84.2	93.4	93.0	59.9	82.1	85.0	36.5	84.7	73.2
4:04	84.8	93.3	92.9	59.9	82.9	84.5	36.3	84.4	73.8
4:19	85.3	93.3	92.2	59.7	83.5	84.3	35.9	85.0	71.0
4:34	86.0	93.8	92.0	60.0	84.1	84.1	35.6	84.0	72.2
4:49	86.4	93.9	92.0	59.7	84.6	83.6	35.3	84.0	68.5
5:04	86.8	94.0	92.0	59.6	85.0	83.3	35.4	83.4	71.0

Experiment No. 4
Filename MRE11.DAT

Initial Temperature of FRH, packaging, and surroundings -- 28.0°C
Initial Temperature of MRE and water -- 30.0°C

Mass of FRH -- 31.7 grams
Mass of water -- 59.2 grams

Average temperature after 300 seconds -- 60.0°C
Change in temperature, ΔT -- 32.0°C

Table A-4. **MRE11.DAT -- Thermocouple Temperatures**

Time	Ch 2	Ch 3	Ch 4	Ch 5	Ch 6	Ch 7	Ch 8	Ch 9	Ch 10
0:00	46.8	88.6	74.1	73.9	29.4	29.6	29.0	27.1	32.5
0:04	70.3	79.9	73.2	71.9	34.9	34.5	29.0	29.4	31.2
0:19	69.5	95.5	76.8	72.8	71.5	46.5	29.7	47.9	30.6
0:34	75.7	90.8	79.1	74.4	82.8	68.5	29.6	56.9	46.3
0:49	75.6	91.6	80.9	75.0	87.2	78.8	31.0	63.0	52.8
1:04	75.0	93.3	82.5	76.9	86.4	80.7	34.8	66.6	57.5
1:19	74.1	92.6	83.6	78.1	86.3	82.7	39.8	71.8	58.2
1:34	73.5	93.7	86.1	78.3	86.3	83.4	45.9	74.8	57.7
1:49	73.4	93.2	87.2	78.5	86.1	84.4	50.6	78.1	60.9
2:04	73.1	93.1	91.8	77.8	86.3	84.2	54.8	79.8	58.7
2:19	73.1	93.5	92.1	79.3	87.1	82.9	56.3	81.4	58.5
2:34	73.4	95.1	92.0	77.6	88.0	81.7	57.0	82.5	63.8
2:49	73.4	93.6	91.8	79.6	86.7	83.1	57.1	83.4	61.2
3:04	73.9	93.6	91.6	79.2	87.3	82.7	56.7	83.2	58.2
3:19	74.5	94.4	91.4	79.0	87.8	82.0	56.2	83.0	61.7
3:34	74.9	94.3	91.4	79.5	88.3	81.2	55.8	83.4	57.7
3:49	75.5	93.4	91.4	79.7	88.8	80.5	55.3	84.2	60.1
4:04	76.0	93.9	91.4	79.7	89.1	80.0	54.8	84.2	59.4
4:19	76.5	94.0	91.5	79.5	89.6	79.7	54.5	84.4	60.4
4:34	77.1	94.0	91.6	79.4	89.9	79.5	54.2	84.4	59.7
4:49	77.6	94.0	91.7	79.6	91.1	79.4	54.0	84.8	60.3
5:04	78.0	94.0	91.8	79.8	90.3	79.5	53.9	84.7	57.7

Experiment No. 6
Filename MRE13.DAT

Initial Temperature of MRE, FRH, packaging, and surroundings -- 25.0°C
Initial Temperature of water -- 30.0°C

Mass of FRH -- 28.2 grams
Mass of water -- 59.2 grams

Average temperature after 300 seconds -- 65.5°C
Change in temperature, $\Delta\hat{}T$ -- 40.5°C

Table A-5. MRE13.DAT -- Thermocouple Temperatures

Time	Ch 2	Ch 3	Ch 4	Ch 5	Ch 6	Ch 7	Ch 8	Ch 9	Ch 10
0:00	30.1	39.5	55.9	52.5	25.8	26.8	26.5	27.5	28.7
0:04	35.3	46.0	63.7	58.3	25.8	26.5	26.4	29.8	28.1
0:19	59.2	62.5	72.8	64.2	27.8	26.4	26.3	46.3	28.7
0:34	69.5	70.0	79.4	67.1	43.0	26.7	26.3	59.3	28.8
0:49	68.8	73.6	80.6	63.6	53.3	29.2	26.2	62.9	33.1
1:04	67.4	75.7	84.8	65.7	58.8	52.3	26.3	53.4	56.0
1:19	66.4	78.6	87.1	66.1	62.6	58.4	29.6	53.8	54.7
1:34	66.4	80.1	89.4	66.6	65.8	63.2	38.1	56.7	57.8
1:49	72.1	80.7	91.2	67.5	65.1	67.3	40.3	64.4	63.7
2:04	73.9	93.0	90.9	67.3	67.2	71.7	40.6	67.6	67.5
2:19	75.5	94.4	92.4	68.4	68.0	74.3	45.0	69.8	70.5
2:34	76.1	94.5	92.8	67.7	69.5	76.4	49.1	72.3	70.0
2:49	77.0	94.4	92.9	67.9	71.3	77.6	56.8	73.8	71.9
3:04	77.5	94.2	91.9	68.3	72.7	78.8	57.2	76.5	69.8
3:19	78.1	93.8	92.0	70.1	74.1	79.6	59.4	75.6	71.8
3:34	78.6	94.8	91.5	70.5	75.1	80.2	61.8	75.2	70.7
3:49	79.3	93.8	92.2	71.3	76.2	80.8	63.6	77.1	66.3
4:04	80.0	94.7	93.0	71.6	77.1	84.1	65.5	80.0	69.6
4:19	80.6	94.6	93.6	72.5	78.1	84.8	67.4	80.2	70.4
4:34	81.1	94.6	94.1	73.3	79.0	85.3	69.1	81.2	70.2
4:49	81.5	93.9	95.0	74.1	79.8	85.7	70.4	80.3	70.1
5:04	82.0	94.4	95.2	74.7	80.6	86.0	71.5	79.9	69.6

Experiment No. 8
Filename MRE15.DAT

Initial Temperature of MRE, FRH, packaging, and surroundings -- 26.5°C
Initial Temperature of water -- 30.0°C

Mass of FRH -- 29.5 grams
Mass of water -- 59.2 grams

Average temperature after 300 seconds -- 62.1°C
Change in temperature, ΔT -- 35.6°C

Table A-6. MRE15.DAT -- Thermocouple Temperatures

Time	Ch 2	Ch 3	Ch 4	Ch 5	Ch 6	Ch 7	Ch 8	Ch 9	Ch 10
0:00		70.0	94.4	41.9	28.1	31.0	27.1	43.6	28.6
0:04		72.8	94.4	38.6	29.8	33.7	27.1	56.7	29.4
0:19		82.0	87.5	45.8	34.6	47.5	28.4	72.4	64.9
0:34		85.3	94.1	47.9	40.5	57.3	42.0	76.8	71.8
0:49		87.5	94.0	49.5	46.3	62.5	64.1	78.5	75.5
1:04		88.4	95.3	50.0	50.7	65.0	68.5	78.9	74.4
1:19		89.2	95.3	50.3	54.4	66.4	67.9	80.0	73.9
1:34		89.9	95.4	51.6	57.5	66.9	66.6	80.5	73.8
1:49		90.4	94.9	49.9	60.2	67.2	64.9	81.0	71.5
2:04		93.5	94.5	52.7	62.7	67.6	63.3	80.9	69.8
2:19		93.6	94.8	53.0	64.9	68.1	62.0	81.5	68.7
2:34		93.6	94.6	51.9	66.9	68.6	60.9	80.7	66.9
2:49		92.3	94.3	54.6	68.7	69.1	60.0	80.3	67.5
3:04		93.8	94.2	52.7	70.3	69.6	60.0	81.2	66.7
3:19		93.8	94.2	50.9	71.9	69.9	59.0	80.2	65.5
3:34		93.9	94.2	49.0	73.3	70.2	58.5	80.9	67.5
3:49		93.9	94.3	48.9	74.6	70.7	58.1	81.2	66.9
4:04		93.8	94.4	51.5	76.5	71.1	57.9	80.5	66.3
4:19		93.4	94.5	53.2	80.0	71.5	57.9	80.8	65.1
4:34		93.4	94.6	55.0	82.3	72.1	58.0	81.6	65.0
4:49		93.6	94.8	56.7	83.6	72.8	58.5	81.4	65.8
5:04		93.9	94.9	58.2	84.7	73.5	58.3	81.6	65.3

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APPENDIX B

SAMPLE INPUT FILE FOR ANSYS TRANSIENT THERMAL ANALYSIS

Appendix B

Sample Input File for ANSYS Transient Thermal Analysis

```
/COM,ANSYS REVISION  4.4    UP437 A 16      18.4109    10/27/1991
/show,340

*****************************************************************************

PREPROCESSING PHASE:
********************

/prep7
/TITLE,MRE
*****************************************************************************

Model specifications:
*********************

KAN,-1
KAY,4,1
ET,1,55
ET,2,55
MP,KXX,1,.355
MP,KXX,2,.392
MP,DENS,1,56.18
MP,DENS,2,81.15
C,1,.7643
C,2,.6998

*****************************************************************************

Model creation stage:
*********************

IMMED,1,0
N,1,0,0
NPLO
N,2,.025,0
N,25,.6,0
NPLO
FILL,2,25
NPLO
```

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N,26,0,.01
N,27,.025,.01
N,50,.6,.01
FILL,27,50
NPLO
N,51,0,.02
N,52,.025,.02
N,75,.6,.02
FILL,52,75
NPLO
N,76,0,.03
N,77,.025,.03
N,100,.6,.03
NPLO
FILL,77,100
NPLO
N,101,0,.04
N,102,.025,.04
N,125,.6,.04
FILL,102,125
NPLO
/RATIO,1,1,10
NPLO
N,126,0,.042
N,127,.025,.042
NPLO
N,142,.4,.042
FILL,127,142
NPLO
TYPE,1
E,1,2,27,26
EGEN,24,1,1
E,26,27,52,51
EGEN,24,1,25
/PNUM,ELEM,1
EPLO
E,51,52,76,75
EPLO
EN,49,51,52,77,76
EGEN,24,1,49
E,76,77,102,101
EGEN,24,1,73
EPLO
TYPE,2
```

```
E,101,102,127,126
EPLO
EGEN,15,197
EGEN,15,1,97
EPLO
EN,112,116,117,142,141
EPLO

*********************************************************************

Time specification:
*******************

TIME,0
ITER,-1,0,1
NT,ALL,TEMP,77
LWRIT
NPLO
TIME,1
ITER,-60,1,1
NTDELE,ALL,TEMP
KBC,1
NPLO
NT,101,TEMP,190,,117
NT,126,TEMP,190,,142
LWRIT
AFWRIT
FINISH

*********************************************************************

SOLUTION PHASE:
***************

/INPUT,27
FINISH

*********************************************************************

POSTPROCESSING PHASE:
*********************

/POST1
SET,2,1
```

```
PLNSTR,TEMP
/RATIO,1,1,10
/SHOW,,,1
PLNSTR,TEMP
SET,2,4
PLNSTR,TEMP
SET,2,60
PLNSTR,TEMP
SET,2,1
/SHOW
PLNSTR,TEMP
fini
/eof
```

****
****

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APPENDIX C

SAMPLE ANSYS OUTPUT FILE

Appendix C

Sample ANSYS Output File

```
***** INPUT SWITCHED FROM FILE05 TO FILE27  NAME=FILE27

NEW TITLE= MRE


OPTION AND TYPE PRINTOUT SUPPRESSED

NUMBER OF ELEMENT TYPES=  2

REAL CONSTANT PRINTOUT SUPPRESSED

NUMBER OF REAL CONSTANT SETS=  0

ELEMENT PRINTOUT SUPPRESSED

SWITCHED TO FIXED FORMAT INPUT
 MAXIMUM NODE NUMBER FOR AVAILABLE AUXILIARY MEMORY SIZE=     169498

 NUMBER OF ELEMENTS =   112     MAXIMUM NODE NUMBER USED =   142

NODE PRINTOUT SUPPRESSED

SWITCHED TO FIXED FORMAT INPUT

 XMIN= 0.0000E+00 XMAX= 0.6000      YMIN= 0.0000E+00 YMAX= 0.4200E-01 ZMIN= 0.0000E+00 ZMAX= 0.0000E+00
 MAXIMUM NODE NUMBER FOR AVAILABLE AUXILIARY MEMORY SIZE=     112998

PROPERTY PRINTOUT SUPPRESSED

MAXIMUM MATERIAL NUMBER=  2

M.D.O.F. PRINTOUT SUPPRESSED

NUMBER OF SPECIFIED MASTER D.O.F.=    0
TOTAL NUMBER OF MASTER D.O.F.  =    0

DISPLACEMENT B.C. PRINTOUT SUPPRESSED

FORCE B.C. PRINTOUT SUPPRESSED

PRESSURE PRINTOUT SUPPRESSED
ELEMENT FORMATION   ELEM=    1 L.S.=   1 ITER=   1  CP=   10.070

 RANGE OF ELEMENT MAXIMUM CONDUCTIVITY IN GLOBAL COORDINATES


 MAXIMUM= 0.148863E+01 AT ELEMENT   112.
 MINIMUM= 0.343167E+00 AT ELEMENT    66.

  *** ELEMENT STIFFNESS FORMULATION TIMES
 TYPE  NUMBER  STIF  TOTAL CP   AVE CP

   1     96    55    0.640    0.007
   2     16    55    0.090    0.006


 TIME AT END OF ELEMENT STIFFNESS FORMULATION  CP=     11.310
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MAXIMUM IN-CORE WAVE FRONT ALLOWED FOR REQUESTED MEMORY SIZE=  300.

MAXIMUM IN-CORE WAVE FRONT=      0.


   MATRIX SOLUTION TIMES
READ IN ELEMENT STIFFNESSES  CP=        0.360


NODAL COORD. TRANSFORMATION  CP=        0.000
MATRIX TRIANGULARIZATION     CP=        0.300


TIME AT END OF MATRIX TRIANGULARIZATION CP=       12.170
STRESS EVALUATION   ELEM=   12 L.S.=   1 ITER=    1  CP=   12.560

 *** ELEM. HT. FLOW CALC. TIMES
TYPE  NUMBER  STIF  TOTAL CP   AVE CP

 1     96    55    0.260  0.003
 2     16    55    0.030  0.002

 *** NODAL HT. FLOW CALC. TIMES
TYPE  NUMBER  STIF  TOTAL CP   AVE CP

 1     96    55    0.130  0.001
 2     16    55    0.010  0.001

*** LOAD STEP   1  ITER    1  COMPLETED.  TIME=  0.000000E+00 TIME INC=  0.000000E+00 NEW TRIANG MATRIX  CUM.
ITER.=    1


 *** STORAGE REQUIREMENT SUMMARY
MAXIMUM FIXED MEMORY USED    =      1506
MAXIMUM TEMPORARY MEMORY USED=       852
MAXIMUM TOTAL MEMORY USED    =      2358
MAXIMUM TEMPORARY AVAILABLE  =    338492


 *** PROBLEM STATISTICS
 NO. OF ACTIVE DEGREES OF FREEDOM =      1
 R.M.S. WAVEFRONT SIZE =     0.0


 *** ANSYS BINARY FILE STATISTICS
BUFFER SIZE USED= 2040
POST DATA WRITTEN ON FILE12
RESTART DATA WRITTEN ON FILE03  (       103412 BYTES)
TEMPERATURES WRITTEN ON FILE04

DISPLACEMENT B.C. PRINTOUT SUPPRESSED

FORCE B.C. PRINTOUT SUPPRESSED

PRESSURE PRINTOUT SUPPRESSED


***** LOAD SUMMARY -    34 TEMPERATURES      0 HEAT FLOWS    0 CONVECTIONS    *****
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ELEMENT FORMATION ELEM= 72 L.S.= 2 ITER= 1 CP= 14.110

***** TEMPERATURE SOLUTION ***** TIME = 0.27667E-03 LOAD STEP= 2 ITERATION= 1 CUM. ITER.= 2

NODE	TEMP	NODE	TEMP	NODE	TEMP	NODE	TEMP	NODE	TEMP
1	77.000	2	77.000	3	77.000	4	77.000	5	77.000
6	77.000	7	77.000	8	77.000	9	77.000	10	77.000
11	77.000	12	77.000	13	77.000	14	77.000	15	77.000
16	77.000	17	77.000	18	77.000	19	77.000	20	77.000
21	77.000	22	77.000	23	77.000	24	77.000	25	77.000
26	77.000	27	77.000	28	77.000	29	77.000	30	77.000
31	77.000	32	77.000	33	77.000	34	77.000	35	77.000
36	77.000	37	77.000	38	77.000	39	77.000	40	77.000
41	77.000	42	77.000	43	77.000	44	77.000	45	77.000
46	77.000	47	77.000	48	77.000	49	77.000	50	77.000
51	77.025	52	77.025	53	77.025	54	77.025	55	77.025
56	77.025	57	77.025	58	77.025	59	77.025	60	77.025
61	77.025	62	77.025	63	77.025	64	77.025	65	77.025
66	77.024	67	77.018	68	77.007	69	77.001	70	77.000
71	77.000	72	77.000	73	77.000	74	77.000	75	77.000
76	78.673	77	78.673	78	78.673	79	78.673	80	78.673
81	78.673	82	78.673	83	78.673	84	78.673	85	78.673
86	78.673	87	78.673	88	78.673	89	78.673	90	78.673
91	78.674	92	78.350	93	77.318	94	76.998	95	77.000
96	77.000	97	77.000	98	77.000	99	77.000	100	77.000
101	190.00	102	190.00	103	190.00	104	190.00	105	190.00
106	190.00	107	190.00	108	190.00	109	190.00	110	190.00
111	190.00	112	190.00	113	190.00	114	190.00	115	190.00
116	190.00	117	190.00	118	76.632	119	77.003	120	77.000
121	77.000	122	77.000	123	77.000	124	77.000	125	77.000
126	190.00	127	190.00	128	190.00	129	190.00	130	190.00
131	190.00	132	190.00	133	190.00	134	190.00	135	190.00
136	190.00	137	190.00	138	190.00	139	190.00	140	190.00
141	190.00	142	190.00						

MAXIMUM TEMPERATURE= 190.00 AT NODE 142
MINIMUM TEMPERATURE= 76.632 AT NODE 118

***** ELEMENT HEAT FLOW RATES ***** TIME = 0.276667E-03 LOAD STEP= 2 ITER.= 1 CUM. ITER.= 2

EL= 1 NODES= 1 2 27 26 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 0.3556E-01 0.3556E-01 TF(X,Y,SUM)= 0.0000E+00 -0.1263E-01 0.1263E-01

EL= 2 NODES= 2 3 28 27 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 0.3556E-01 0.3556E-01 TF(X,Y,SUM)= 0.0000E+00 -0.1263E-01 0.1263E-01

EL= 3 NODES= 3 4 29 28 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.5684E-13 0.3556E-01 0.3556E-01 TF(X,Y,SUM)= -0.2018E-13 -0.1263E-01 0.1263E-01

EL= 4 NODES= 4 5 30 29 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.5684E-13 0.3556E-01 0.3556E-01 TF(X,Y,SUM)= -0.2018E-13 -0.1263E-01 0.1263E-01

EL= 5 NODES= 5 6 31 30 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.2842E-13 0.3556E-01 0.3556E-01 TF(X,Y,SUM)= -0.1009E-13 -0.1263E-01 0.1263E-01

EL= 6 NODES= 6 7 32 31 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 0.3556E-01 0.3556E-01 TF(X,Y,SUM)= 0.0000E+00 -0.1263E-01 0.1263E-01

EL= 7 NODES= 7 8 33 32 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 0.3556E-01 0.3556E-01 TF(X,Y,SUM)= 0.0000E+00 -0.1263E-01 0.1263E-01

EL= 8 NODES= 8 9 34 33 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.1137E-12 0.3556E-01 0.3556E-01 TF(X,Y,SUM)= 0.4036E-13 -0.1263E-01 0.1263E-01

EL= 9 NODES= 9 10 35 34 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.5684E-13 0.3556E-01 0.3556E-01 TF(X,Y,SUM)= -0.2018E-13 -0.1263E-01 0.1263E-01

EL= 10 NODES= 10 11 36 35 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.2842E-13 0.3556E-01 0.3556E-01 TF(X,Y,SUM)= 0.1009E-13 -0.1263E-01 0.1263E-01

EL= 11 NODES= 11 12 37 36 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.5286E-11 0.3556E-01 0.3556E-01 TF(X,Y,SUM)= -0.1877E-11 -0.1263E-01 0.1263E-01

EL= 12 NODES= 12 13 38 37 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.1257E-08 0.3556E-01 0.3556E-01 TF(X,Y,SUM)= 0.4462E-09 -0.1263E-01 0.1263E-01

EL= 13 NODES= 13 14 39 38 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.2265E-06 0.3557E-01 0.3557E-01 TF(X,Y,SUM)= -0.8040E-07 -0.1263E-01 0.1263E-01

EL= 14 NODES= 14 15 40 39 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.5296E-04 0.3545E-01 0.3545E-01 TF(X,Y,SUM)= 0.1880E-04 -0.1259E-01 0.1259E-01

EL= 15 NODES= 15 16 41 40 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.5170E-03 0.3414E-01 0.3415E-01 TF(X,Y,SUM)= 0.1835E-03 -0.1212E-01 0.1212E-01

EL= 16 NODES= 16 17 42 41 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.1816E-02 0.2866E-01 0.2872E-01 TF(X,Y,SUM)= 0.6446E-03 -0.1018E-01 0.1020E-01

EL= 17 NODES= 17 18 43 42 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.2791E-02 0.1775E-01 0.1796E-01 TF(X,Y,SUM)= 0.9907E-03 -0.6300E-02 0.6378E-02

EL= 18 NODES= 18 19 44 43 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.1808E-02 0.6849E-02 0.7084E-02 TF(X,Y,SUM)= 0.6420E-03 -0.2431E-02 0.2515E-02

EL= 19 NODES= 19 20 45 44 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.5113E-03 0.1398E-02 0.1488E-02 TF(X,Y,SUM)= 0.1815E-03 -0.4963E-03 0.5284E-03

EL= 20 NODES= 20 21 46 45 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.5131E-04 0.1057E-03 0.1175E-03 TF(X,Y,SUM)= 0.1822E-04 -0.3753E-04 0.4172E-04

EL= 21 NODES= 21 22 47 46 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.3862E-06 -0.2160E-05 0.2194E-05 TF(X,Y,SUM)= -0.1371E-06 0.7667E-06 0.7789E-06

EL= 22 NODES= 22 23 48 47 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.3328E-08 0.2951E-07 0.2969E-07 TF(X,Y,SUM)= 0.1182E-08 -0.1048E-07 0.1054E-07

EL= 23 NODES= 23 24 49 48 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.2498E-10 -0.3433E-09 0.3442E-09 TF(X,Y,SUM)= -0.8869E-11 0.1219E-09 0.1222E-09

EL= 24 NODES= 24 25 50 49 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.2842E-12 0.3695E-11 0.3706E-11 TF(X,Y,SUM)= 0.1009E-12 -0.1312E-11 0.1316E-11

EL= 25 NODES= 26 27 52 51 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.2842E-13 2.439 2.439 TF(X,Y,SUM)= -0.1009E-13 -0.8658 0.8658

EL= 26 NODES= 27 28 53 52 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.2842E-13 2.439 2.439 TF(X,Y,SUM)= -0.1009E-13 -0.8658 0.8658

EL= 27 NODES= 28 29 54 53 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.2842E-13 2.439 2.439 TF(X,Y,SUM)= 0.1009E-13 -0.8658 0.8658

EL= 28 NODES= 29 30 55 54 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.8527E-13 2.439 2.439 TF(X,Y,SUM)= -0.3027E-13 -0.8658 0.8658

EL= 29 NODES= 30 31 56 55 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.2842E-13 2.439 2.439 TF(X,Y,SUM)= -0.1009E-13 -0.8658 0.8658

EL= 30 NODES= 31 32 57 56 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 2.439 2.439 TF(X,Y,SUM)= 0.0000E+00 -0.8658 0.8658

EL= 31 NODES= 32 33 58 57 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.5684E-13 2.439 2.439 TF(X,Y,SUM)= 0.2018E-13 -0.8658 0.8658

EL= 32 NODES= 33 34 59 58 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.2842E-13 2.439 2.439 TF(X,Y,SUM)= 0.1009E-13 -0.8658 0.8658

EL= 33 NODES= 34 35 60 59 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.2842E-13 2.439 2.439 TF(X,Y,SUM)= -0.1009E-13 -0.8658 0.8658

EL= 34 NODES= 35 36 61 60 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.5684E-13 2.439 2.439 TF(X,Y,SUM)= -0.2018E-13 -0.8658 0.8658

EL= 35 NODES= 36 37 62 61 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.4945E-11 2.439 2.439 TF(X,Y,SUM)= 0.1756E-11 -0.8658 0.8658

EL= 36 NODES= 37 38 63 62 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.1605E-08 2.439 2.439 TF(X,Y,SUM)= -0.5698E-09 -0.8658 0.8658

EL= 37 NODES= 38 39 64 63 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.3985E-06 2.439 2.439 TF(X,Y,SUM)= 0.1415E-06 -0.8658 0.8658

EL= 38 NODES= 39 40 65 64 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.7004E-04 2.439 2.439 TF(X,Y,SUM)= -0.2486E-04 -0.8660 0.8660

EL= 39 NODES= 40 41 66 65 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.1853E-01 2.396 2.396 TF(X,Y,SUM)= 0.6578E-02 -0.8505 0.8506

EL= 40 NODES= 41 42 67 66 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.1195 2.062 2.066 TF(X,Y,SUM)= 0.4241E-01 -0.7321 0.7333

EL= 41 NODES= 42 43 68 67 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.2277 1.217 1.238 TF(X,Y,SUM)= 0.8085E-01 -0.4319 0.4394

EL= 42 NODES= 43 44 69 68 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.1188 0.3728 0.3913 TF(X,Y,SUM)= 0.4216E-01 -0.1324 0.1389

EL= 43 NODES= 44 45 70 69 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.1814E-01 0.4180E-01 0.4557E-01 TF(X,Y,SUM)= 0.6441E-02 -0.1484E-01 0.1618E-01

EL= 44 NODES= 45 46 71 70 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.1275E-03 -0.5454E-03 0.5601E-03 TF(X,Y,SUM)= -0.4527E-04 0.1936E-03 0.1988E-03

EL= 45 NODES= 46 47 72 71 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.1104E-05 0.5829E-05 0.5933E-05 TF(X,Y,SUM)= 0.3921E-06 -0.2069E-05 0.2106E-05

EL= 46 NODES= 47 48 73 72 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.8221E-08 -0.5795E-07 0.5853E-07 TF(X,Y,SUM)= -0.2919E-08 0.2057E-07 0.2078E-07

EL= 47 NODES= 48 49 74 73 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.6193E-10 0.5574E-09 0.5608E-09 TF(X,Y,SUM)= 0.2199E-10 -0.1979E-09 0.1991E-09

EL= 48 NODES= 49 50 75 74 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.4832E-12 -0.5116E-11 0.5139E-11 TF(X,Y,SUM)= -0.1715E-12 0.1816E-11 0.1824E-11

EL= 49 NODES= 51 52 77 76 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.5684E-13 164.8 164.8 TF(X,Y,SUM)= -0.2018E-13 -58.50 58.50

EL= 50 NODES= 52 53 78 77 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.2842E-13 164.8 164.8 TF(X,Y,SUM)= 0.1009E-13 -58.50 58.50

EL= 51 NODES= 53 54 79 78 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.2842E-13 164.8 164.8 TF(X,Y,SUM)= 0.1009E-13 -58.50 58.50

EL= 52 NODES= 54 55 80 79 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 164.8 164.8 TF(X,Y,SUM)= 0.0000E+00 -58.50 58.50

EL= 53 NODES= 55 56 81 80 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.2842E-13 164.8 164.8 TF(X,Y,SUM)= -0.1009E-13 -58.50 58.50

EL= 54 NODES= 56 57 82 81 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 164.8 164.8 TF(X,Y,SUM)= 0.0000E+00 -58.50 58.50

EL= 55 NODES= 57 58 83 82 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.1137E-12 164.8 164.8 TF(X,Y,SUM)= 0.4036E-13 -58.50 58.50

EL= 56 NODES= 58 59 84 83 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.2842E-13 164.8 164.8 TF(X,Y,SUM)= -0.1009E-13 -58.50 58.50

EL= 57 NODES= 59 60 85 84 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.5684E-13 164.8 164.8 TF(X,Y,SUM)= -0.2018E-13 -58.50 58.50

EL= 58 NODES= 60 61 86 85 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.2274E-12 164.8 164.8 TF(X,Y,SUM)= -0.8072E-13 -58.50 58.50

EL= 59 NODES= 61 62 87 86 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.1455E-10 164.8 164.8 TF(X,Y,SUM)= 0.5166E-11 -58.50 58.50

EL= 60 NODES= 62 63 88 87 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.1445E-08 164.8 164.8 TF(X,Y,SUM)= -0.5130E-09 -58.50 58.50

EL= 61 NODES= 63 64 89 88 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.1369E-06 164.8 164.8 TF(X,Y,SUM)= 0.4861E-07 -58.50 58.50

EL= 62 NODES= 64 65 90 89 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.3547E-05 164.8 164.8 TF(X,Y,SUM)= 0.1259E-05 -58.50 58.50

EL= 63 NODES= 65 66 91 90 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.3288E-02 164.9 164.9 TF(X,Y,SUM)= -0.1167E-02 -58.53 58.53

EL= 64 NODES= 66 67 92 91 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -6.580 149.1 149.3 TF(X,Y,SUM)= 2.336 -52.93 52.99
STRESS EVALUATION ELEM= 65 L.S.= 2 ITER= 1 CP= 16.180

EL= 65 NODES= 67 68 93 92 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -20.88 82.17 84.78 TF(X,Y,SUM)= 7.413 -29.17 30.10

EL= 66 NODES= 68 69 94 93 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -6.512 15.40 16.72 TF(X,Y,SUM)= 2.312 -5.467 5.936

EL= 67 NODES= 69 70 95 94 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.2426E-01 -0.1463 0.1483 TF(X,Y,SUM)= -0.8613E-02 0.5192E-01 0.5263E-01

EL= 68 NODES= 70 71 96 95 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.1877E-03 0.1322E-02 0.1335E-02 TF(X,Y,SUM)= 0.6663E-04 -0.4693E-03 0.4740E-03

EL= 69 NODES= 71 72 97 96 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.1212E-05 -0.1153E-04 0.1160E-04 TF(X,Y,SUM)= -0.4301E-06 0.4095E-05 0.4117E-05

EL= 70 NODES= 72 73 98 97 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55

TG(X,Y,SUM)= -0.8816E-08 0.9992E-07 0.1003E-06 TF(X,Y,SUM)= 0.3130E-08 -0.3547E-07 0.3561E-07

EL= 71 NODES= 73 74 99 98 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.6338E-10 -0.8661E-09 0.8684E-09 TF(X,Y,SUM)= -0.2250E-10 0.3075E-09 0.3083E-09

EL= 72 NODES= 74 75 100 99 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.3126E-12 0.7560E-11 0.7567E-11 TF(X,Y,SUM)= 0.1110E-12 -0.2684E-11 0.2686E-11

EL= 73 NODES= 76 77 102 101 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.5684E-13 0.1113E+05 0.1113E+05 TF(X,Y,SUM)= -0.2018E-13 -3952. 3952.

EL= 74 NODES= 77 78 103 102 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.5684E-13 0.1113E+05 0.1113E+05 TF(X,Y,SUM)= 0.2018E-13 -3952. 3952.

EL= 75 NODES= 78 79 104 103 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 0.1113E+05 0.1113E+05 TF(X,Y,SUM)= 0.0000E+00 -3952. 3952.

EL= 76 NODES= 79 80 105 104 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 0.1113E+05 0.1113E+05 TF(X,Y,SUM)= 0.0000E+00 -3952. 3952.

EL= 77 NODES= 80 81 106 105 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 0.1113E+05 0.1113E+05 TF(X,Y,SUM)= 0.0000E+00 -3952. 3952.

EL= 78 NODES= 81 82 107 106 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 0.1113E+05 0.1113E+05 TF(X,Y,SUM)= 0.0000E+00 -3952. 3952.

EL= 79 NODES= 82 83 108 107 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 0.1113E+05 0.1113E+05 TF(X,Y,SUM)= 0.0000E+00 -3952. 3952.

EL= 80 NODES= 83 84 109 108 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 0.1113E+05 0.1113E+05 TF(X,Y,SUM)= 0.0000E+00 -3952. 3952.

EL= 81 NODES= 84 85 110 109 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.5684E-13 0.1113E+05 0.1113E+05 TF(X,Y,SUM)= -0.2018E-13 -3952. 3952.

EL= 82 NODES= 85 86 111 110 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.2274E-12 0.1113E+05 0.1113E+05 TF(X,Y,SUM)= 0.8072E-13 -3952. 3952.

EL= 83 NODES= 86 87 112 111 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.3513E-10 0.1113E+05 0.1113E+05 TF(X,Y,SUM)= -0.1247E-10 -3952. 3952.

EL= 84 NODES= 87 88 113 112 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.5031E-08 0.1113E+05 0.1113E+05 TF(X,Y,SUM)= 0.1786E-08 -3952. 3952.

EL= 85 NODES= 88 89 114 113 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.7504E-06 0.1113E+05 0.1113E+05 TF(X,Y,SUM)= -0.2664E-06 -3952. 3952.

EL= 86 NODES= 89 90 115 114 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.1228E-03 0.1113E+05 0.1113E+05 TF(X,Y,SUM)= 0.4361E-04 -3952. 3952.

EL= 87 NODES= 90 91 116 115 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.2132E-01 0.1113E+05 0.1113E+05 TF(X,Y,SUM)= -0.7569E-02 -3952. 3952.

EL= 88 NODES= 91 92 117 116 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -6.463 0.1115E+05 0.1115E+05 TF(X,Y,SUM)= 2.294 -3958. 3958.

EL= 89 NODES= 92 93 118 117 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -2288. 5548. 6001. TF(X,Y,SUM)= 812.2 -1970. 2131.

EL= 90 NODES= 93 94 119 118 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 1.026 -34.03 34.04 TF(X,Y,SUM)= -0.3642 12.08 12.09

EL= 91 NODES= 94 95 120 119 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.1922E-01 0.2536 0.2544 TF(X,Y,SUM)= 0.6823E-02 -0.9004E-01 0.9030E-01

EL= 92 NODES= 95 96 121 120 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.7844E-04 -0.1978E-02 0.1980E-02 TF(X,Y,SUM)= -0.2784E-04 0.7023E-03 0.7028E-03

EL= 93 NODES= 96 97 122 121 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.5737E-06 0.1594E-04 0.1595E-04 TF(X,Y,SUM)= 0.2037E-06 -0.5657E-05 0.5661E-05

EL= 94 NODES= 97 98 123 122 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.3729E-08 -0.1308E-06 0.1309E-06 TF(X,Y,SUM)= -0.1324E-08 0.4645E-07 0.4647E-07

EL= 95 NODES= 98 99 124 123 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= -0.2689E-10 0.1089E-08 0.1089E-08 TF(X,Y,SUM)= 0.9545E-11 -0.3864E-09 0.3866E-09

EL= 96 NODES= 99 100 125 124 MAT= 1 VOL= 0.2500E-03 2-D SOLID 55
TG(X,Y,SUM)= 0.3411E-12 -0.9322E-11 0.9329E-11 TF(X,Y,SUM)= -0.1211E-12 0.3309E-11 0.3312E-11

EL= 97 NODES= 101 102 127 126 MAT= 1 VOL= 0.5000E-04 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 0.0000E+00 0.0000E+00 TF(X,Y,SUM)= 0.0000E+00 0.0000E+00 0.0000E+00

EL= 98 NODES= 102 103 128 127 MAT= 1 VOL= 0.5000E-04 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 -0.9095E-12 0.9095E-12 TF(X,Y,SUM)= 0.0000E+00 0.3229E-12 0.3229E-12

EL= 99 NODES= 103 104 129 128 MAT= 1 VOL= 0.5000E-04 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 -0.9095E-12 0.9095E-12 TF(X,Y,SUM)= 0.0000E+00 0.3229E-12 0.3229E-12

EL= 100 NODES= 104 105 130 129 MAT= 1 VOL= 0.5000E-04 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 -0.9095E-12 0.9095E-12 TF(X,Y,SUM)= 0.0000E+00 0.3229E-12 0.3229E-12

EL= 101 NODES= 105 106 131 130 MAT= 1 VOL= 0.5000E-04 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 -0.9095E-12 0.9095E-12 TF(X,Y,SUM)= 0.0000E+00 0.3229E-12 0.3229E-12

EL= 102 NODES= 106 107 132 131 MAT= 1 VOL= 0.5000E-04 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 0.0000E+00 0.0000E+00 TF(X,Y,SUM)= 0.0000E+00 0.0000E+00 0.0000E+00

EL= 103 NODES= 107 108 133 132 MAT= 1 VOL= 0.5000E-04 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 -0.9095E-12 0.9095E-12 TF(X,Y,SUM)= 0.0000E+00 0.3229E-12 0.3229E-12

EL= 104 NODES= 108 109 134 133 MAT= 1 VOL= 0.5000E-04 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 0.0000E+00 0.0000E+00 TF(X,Y,SUM)= 0.0000E+00 0.0000E+00 0.0000E+00

EL= 105 NODES= 109 110 135 134 MAT= 1 VOL= 0.5000E-04 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 -0.9095E-12 0.9095E-12 TF(X,Y,SUM)= 0.0000E+00 0.3229E-12 0.3229E-12

EL= 106 NODES= 110 111 136 135 MAT= 1 VOL= 0.5000E-04 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 0.0000E+00 0.0000E+00 TF(X,Y,SUM)= 0.0000E+00 0.0000E+00 0.0000E+00

EL= 107 NODES= 111 112 137 136 MAT= 1 VOL= 0.5000E-04 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 -0.9095E-12 0.9095E-12 TF(X,Y,SUM)= 0.0000E+00 0.3229E-12 0.3229E-12

EL= 108 NODES= 112 113 138 137 MAT= 1 VOL= 0.5000E-04 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 -0.9095E-12 0.9095E-12 TF(X,Y,SUM)= 0.0000E+00 0.3229E-12 0.3229E-12

EL= 109 NODES= 113 114 139 138 MAT= 1 VOL= 0.5000E-04 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 0.0000E+00 0.0000E+00 TF(X,Y,SUM)= 0.0000E+00 0.0000E+00 0.0000E+00

EL= 110 NODES= 114 115 140 139 MAT= 1 VOL= 0.5000E-04 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 -0.9095E-12 0.9095E-12 TF(X,Y,SUM)= 0.0000E+00 0.3229E-12 0.3229E-12

EL= 111 NODES= 115 116 141 140 MAT= 1 VOL= 0.5000E-04 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 -0.9095E-12 0.9095E-12 TF(X,Y,SUM)= 0.0000E+00 0.3229E-12 0.3229E-12

EL= 112 NODES= 116 117 142 141 MAT= 1 VOL= 0.5000E-04 2-D SOLID 55
TG(X,Y,SUM)= 0.0000E+00 -0.9095E-12 0.9095E-12 TF(X,Y,SUM)= 0.0000E+00 0.3229E-12 0.3229E-12

***** NODAL HEAT FLOW RATES ***** TIME = 0.27667E-03 LOAD STEP= 2 ITERATION= 1 CUM. ITER.= 2

NOTE - HEAT FLOW RATES ARE POSITIVE INTO THE NODE.
SPECIFIC HEAT FLOWS ARE NOT INCLUDED.

NODE	HEAT
101	49.4016
102	98.8031
103	98.8031
104	98.8031
105	98.8031
106	98.8031
107	98.8031
108	98.8031
109	98.8031
110	98.8031
111	98.8031
112	98.8031
113	98.8031
114	98.8031
115	98.8029
116	98.8578
117	87.8078
126	0.000000E+00
127	0.355271E-14
128	-0.106581E-13
129	0.355271E-14
130	-0.142109E-13
131	-0.355271E-14
132	-0.355271E-14
133	-0.355271E-14
134	0.355271E-14
135	-0.142109E-13
136	0.000000E+00
137	0.106581E-13
138	0.355271E-14
139	0.355271E-14
140	0.000000E+00
141	0.710543E-14
142	0.000000E+00

TOTAL 1619.31

*** LOAD STEP 2 ITER 1 COMPLETED. TIME= 0.276667E-03

APPENDIX D

EXPERIMENTAL RESULTS FOR THE MRE

Table D-1. Summary of MRE Results

Nodal temperatures at 300 seconds.
Heater temperature for all cases, 87.46°C (190°F)

Summary of Results	
Boundary Condition	Final Average Temperature
Adiabatic	56.78°C (134.21°F)
T_s = 48.89°C (120°F)	61.48°C (142.66°F)
T_s = 60.00°C (140°F)	68.89°C (156.01°F)
T_s = 71.11°C (160°F)	76.32°C (169.38°F)
T_s = 82.22°C (180°F)	83.74°C (182.73°F)
T_s = 87.78°C (190°F)	87.46°C (189.43°F)

Adiabatic Condition

Node	Temp°F	Node	Temp°C
1	140.17	1	60.09
2	140.17	2	60.09
3	140.17	3	60.09
4	140.17	4	60.09
5	140.17	5	60.09
6	140.17	6	60.09
7	140.17	7	60.09
8	140.17	8	60.09
9	140.17	9	60.09
10	140.17	10	60.09
11	140.17	11	60.09
12	140.17	12	60.09
13	140.14	13	60.08
14	139.99	14	59.99
15	139.06	15	59.48
16	134.35	16	56.86
17	120.56	17	49.20
18	100.02	18	37.79
19	85.06	19	29.48

Adiabatic Condition

Node	Temp°F	Node	Temp°C
20	79.07	20	26.15
21	77.46	21	25.26
22	77.09	22	25.05
23	77.02	23	25.01
24	77.00	24	25.00
25	77.00	25	25.00
26	144.08	26	62.27
27	144.08	27	62.27
28	144.08	28	62.27
29	144.08	29	62.27
30	144.08	30	62.27
31	144.08	31	62.27
32	144.08	32	62.27
33	144.08	33	62.27
34	144.08	34	62.27
35	144.08	35	62.27
36	144.08	36	62.27
37	144.07	37	62.26
38	144.05	38	62.25

Adiabatic Condition

Node	Temp°F	Node	Temp°C
39	143.90	39	62.17
40	143.07	40	61.71
41	138.70	41	59.28
42	124.28	42	51.27
43	101.15	43	38.42
44	85.08	44	29.49
45	79.07	45	26.15
46	77.46	46	25.26
47	77.09	47	25.05
48	77.02	48	25.01
49	77.00	49	25.00
50	77.00	50	25.00
51	155.05	51	68.36
52	155.05	52	68.36
53	155.05	53	68.36
54	155.05	54	68.36
55	155.05	55	68.36
56	155.05	56	68.36
57	155.05	57	68.36
58	155.05	58	68.36
59	155.05	59	68.36
60	155.05	60	68.36
61	155.05	61	68.36
62	155.05	62	68.36
63	155.03	63	68.35
64	154.91	64	68.28
65	154.30	65	67.94
66	151.14	66	66.19
67	135.55	67	57.53
68	103.98	68	39.99
69	85.04	69	29.47
70	79.09	70	26.16
71	77.46	71	25.26
72	77.09	72	25.05
73	77.02	73	25.01
74	77.00	74	25.00
75	77.00	75	25.00
76	171.18	76	77.32
77	171.18	77	77.32
78	171.18	78	77.32

Adiabatic Condition

Node	Temp°F	Node	Temp°C
79	171.18	79	77.32
80	171.18	80	77.32
81	171.18	81	77.32
82	171.18	82	77.32
83	171.18	83	77.32
84	171.18	84	77.32
85	171.18	85	77.32
86	171.18	86	77.32
87	171.18	87	77.32
88	171.17	88	77.32
89	171.13	89	77.29
90	170.67	90	77.04
91	169.72	91	76.51
92	155.57	92	68.65
93	106.34	93	41.30
94	84.88	94	29.38
95	79.18	95	26.21
96	77.44	96	25.25
97	77.10	97	25.05
98	77.02	98	25.01
99	77.00	99	25.00
100	77.00	100	25.00
101	190.00	101	87.78
102	190.00	102	87.78
103	190.00	103	87.78
104	190.00	104	87.78
105	190.00	105	87.78
106	190.00	106	87.78
107	190.00	107	87.78
108	190.00	108	87.78
109	190.00	109	87.78
110	190.00	110	87.78
111	190.00	111	87.78
112	190.00	112	87.78
113	190.00	113	87.78
114	190.00	114	87.78
115	190.00	115	87.78
116	190.00	116	87.78
117	190.00	117	87.78
118	101.78	118	38.77

Adiabatic Condition

Node	Temp°F	Node	Temp°C
119	86.01	119	30.01
120	78.95	120	26.08
121	77.49	121	25.27
122	77.08	122	25.05
123	77.02	123	25.01
124	77.00	124	25.00
125	77.00	125	25.00
126	190.00	126	87.78
127	190.00	127	87.78
128	190.00	128	87.78
129	190.00	129	87.78
130	190.00	130	87.78
131	190.00	131	87.78
132	190.00	132	87.78
133	190.00	133	87.78
134	190.00	134	87.78
135	190.00	135	87.78
136	190.00	136	87.78
137	190.00	137	87.78
138	190.00	138	87.78
139	190.00	139	87.78
140	190.00	140	87.78
141	190.00	141	87.78
142	190.00	142	87.78

T_s = 48.9°C (120°F) Condition

Node	Temp°F	Node	Temp°C
1	120.00	1	48.89
2	120.00	2	48.89
3	120.00	3	48.89
4	120.00	4	48.89
5	120.00	5	48.89
6	120.00	6	48.89
7	120.00	7	48.89
8	120.00	8	48.89
9	120.00	9	48.89
10	120.00	10	48.89

T_s = 48.9°C (120°F) Condition

Node	Temp°F	Node	Temp°C
11	120.00	11	48.89
12	120.00	12	48.89
13	120.00	13	48.89
14	120.00	14	48.89
15	120.00	15	48.89
16	120.00	16	48.89
17	120.00	17	48.89
18	120.00	18	48.89
19	120.00	19	48.89
20	120.00	20	48.89
21	120.00	21	48.89
22	120.00	22	48.89
23	120.00	23	48.89
24	120.00	24	48.89
25	120.00	25	48.89
26	120.00	26	48.89
27	133.69	27	56.49
28	137.08	28	58.38
29	137.01	29	58.34
30	137.02	30	58.34
31	137.02	31	58.34
32	137.02	32	58.34
33	137.02	33	58.34
34	137.02	34	58.34
35	137.02	35	58.34
36	137.02	36	58.34
37	137.02	37	58.34
38	137.02	38	58.34
39	137.01	39	58.34
40	137.02	40	58.34
41	136.37	41	57.98
42	132.21	42	55.67
43	124.54	43	51.41
44	120.39	44	49.11
45	119.73	45	48.74
46	119.74	46	48.74
47	119.74	47	48.74
48	119.76	48	48.76
49	119.88	49	48.82
50	120.00	50	48.89

T_s = 120 Condition				T_s = 48.9°C (120°F) Condition			
Node	Temp°F	Node	Temp°C	Node	Temp°F	Node	Temp°C
51	120.00	51	48.89	91	172.01	91	77.78
52	150.20	52	65.67	92	162.86	92	72.70
53	154.53	53	68.07	93	128.88	93	53.82
54	154.24	54	67.91	94	119.73	94	48.74
55	154.33	55	67.96	95	119.83	95	48.79
56	154.31	56	67.95	96	119.72	96	48.73
57	154.32	57	67.96	97	119.74	97	48.74
58	154.32	58	67.96	98	119.76	98	48.76
59	154.32	59	67.96	99	119.88	99	48.82
60	154.32	60	67.96	100	120.00	100	48.89
61	154.32	61	67.96	101	190.00	101	87.78
62	154.32	62	67.96	102	190.00	102	87.78
63	154.32	63	67.96	103	190.00	103	87.78
64	154.31	64	67.95	104	190.00	104	87.78
65	154.31	65	67.95	105	190.00	105	87.78
66	153.58	66	67.54	106	190.00	106	87.78
67	145.73	67	63.18	107	190.00	107	87.78
68	128.21	68	53.45	108	190.00	108	87.78
69	120.36	69	49.09	109	190.00	109	87.78
70	119.63	70	48.68	110	190.00	110	87.78
71	119.63	71	48.68	111	190.00	111	87.78
72	119.63	72	48.68	112	190.00	112	87.78
73	119.66	73	48.70	113	190.00	113	87.78
74	119.83	74	48.79	114	190.00	114	87.78
75	120.00	75	48.89	115	190.00	115	87.78
76	120.00	76	48.89	116	190.00	116	87.78
77	173.96	77	78.87	117	190.00	117	87.78
78	171.28	78	77.38	118	120.00	118	48.89
79	172.12	79	77.84	119	120.00	119	48.89
80	171.99	80	77.77	120	120.00	120	48.89
81	172.02	81	77.79	121	120.00	121	48.89
82	172.01	82	77.78	122	120.00	122	48.89
83	172.01	83	77.78	123	120.00	123	48.89
84	172.01	84	77.78	124	120.00	124	48.89
85	172.01	85	77.78	125	120.00	125	48.89
86	172.01	86	77.78	126	190.00	126	87.78
87	172.01	87	77.78	127	190.00	127	87.78
88	172.01	88	77.78	128	190.00	128	87.78
89	172.03	89	77.79	129	190.00	129	87.78
90	171.92	90	77.73	130	190.00	130	87.78

T_s = 48.9°C (120°F) Condition

Node	Temp°F	Node	Temp°C
131	190.00	131	87.78
132	190.00	132	87.78
133	190.00	133	87.78
134	190.00	134	87.78
135	190.00	135	87.78
136	190.00	136	87.78
137	190.00	137	87.78
138	190.00	138	87.78
139	190.00	139	87.78
140	190.00	140	87.78
141	190.00	141	87.78
142	190.00	142	87.78

T_s = 60.0°C (140°F) Condition

Node	Temp°F	Node	Temp°C
1	140.00	1	60.00
2	140.00	2	60.00
3	140.00	3	60.00
4	140.00	4	60.00
5	140.00	5	60.00
6	140.00	6	60.00
7	140.00	7	60.00
8	140.00	8	60.00
9	140.00	9	60.00
10	140.00	10	60.00
11	140.00	11	60.00
12	140.00	12	60.00
13	140.00	13	60.00
14	140.00	14	60.00
15	140.00	15	60.00
16	140.00	16	60.00
17	140.00	17	60.00
18	140.00	18	60.00
19	140.00	19	60.00
20	140.00	20	60.00
21	140.00	21	60.00
22	140.00	22	60.00

T_s = 60.0°C (140°F) Condition

Node	Temp°F	Node	Temp°C
23	140.00	23	60.00
24	140.00	24	60.00
25	140.00	25	60.00
26	140.00	26	60.00
27	149.60	27	65.33
28	151.92	28	66.62
29	151.85	29	66.58
30	151.86	30	66.59
31	151.86	31	66.59
32	151.86	32	66.59
33	151.86	33	66.59
34	151.86	34	66.59
35	151.86	35	66.59
36	151.86	36	66.59
37	151.86	37	66.59
38	151.86	38	66.59
39	151.86	39	66.59
40	151.86	40	66.59
41	151.39	41	66.33
42	148.43	42	64.68
43	142.97	43	61.65
44	140.01	44	60.01
45	139.54	45	59.74
46	139.54	46	59.74
47	139.54	47	59.74
48	139.58	48	59.77
49	139.75	49	59.86
50	140.00	50	60.00
51	140.00	51	60.00
52	161.31	52	71.84
53	164.27	53	73.48
54	164.04	54	73.36
55	164.10	55	73.39
56	164.09	56	73.38
57	164.09	57	73.38
58	164.09	58	73.38
59	164.09	59	73.38
60	164.09	60	73.38
61	164.09	61	73.38
62	164.09	62	73.38

T_s = 60.0°C (140°F) Condition

Node	Temp°F	Node	Temp°C
63	164.09	63	73.38
64	164.09	64	73.38
65	164.09	65	73.38
66	163.57	66	73.09
67	157.97	67	69.98
68	145.48	68	63.04
69	139.88	69	59.93
70	139.35	70	59.64
71	139.36	71	59.64
72	139.35	72	59.64
73	139.40	73	59.67
74	139.65	74	59.81
75	140.00	75	60.00
76	140.00	76	60.00
77	178.35	77	81.31
78	176.35	78	80.19
79	176.94	79	80.52
80	176.84	80	80.47
81	176.86	81	80.48
82	176.86	82	80.48
83	176.86	83	80.48
84	176.86	84	80.48
85	176.86	85	80.48
86	176.86	86	80.48
87	176.86	87	80.48
88	176.85	88	80.47
89	176.86	89	80.48
90	176.79	90	80.44
91	176.86	91	80.48
92	170.33	92	76.85
93	146.07	93	63.37
94	139.54	94	59.74
95	139.61	95	59.78
96	139.53	96	59.74
97	139.55	97	59.75
98	139.58	98	59.77
99	139.75	99	59.86
100	140.00	100	60.00
101	190.00	101	87.78
102	190.00	102	87.78

T_s = 60.0°C (140°F) Condition

Node	Temp°F	Node	Temp°C
103	190.00	103	87.78
104	190.00	104	87.78
105	190.00	105	87.78
106	190.00	106	87.78
107	190.00	107	87.78
108	190.00	108	87.78
109	190.00	109	87.78
110	190.00	110	87.78
111	190.00	111	87.78
112	190.00	112	87.78
113	190.00	113	87.78
114	190.00	114	87.78
115	190.00	115	87.78
116	190.00	116	87.78
117	190.00	117	87.78
118	140.00	118	60.00
119	140.00	119	60.00
120	140.00	120	60.00
121	140.00	121	60.00
122	140.00	122	60.00
123	140.00	123	60.00
124	140.00	124	60.00
125	140.00	125	60.00
126	190.00	126	87.78
127	190.00	127	87.78
128	190.00	128	87.78
129	190.00	129	87.78
130	190.00	130	87.78
131	190.00	131	87.78
132	190.00	132	87.78
133	190.00	133	87.78
134	190.00	134	87.78
135	190.00	135	87.78
136	190.00	136	87.78
137	190.00	137	87.78
138	190.00	138	87.78
139	190.00	139	87.78
140	190.00	140	87.78
141	190.00	141	87.78
142	190.00	142	87.78

T_s = 71.1°C (160°F) Condition

Node	Temp°F	Node	Temp°C
1	160.00	1	71.11
2	160.00	2	71.11
3	160.00	3	71.11
4	160.00	4	71.11
5	160.00	5	71.11
6	160.00	6	71.11
7	160.00	7	71.11
8	160.00	8	71.11
9	160.00	9	71.11
10	160.00	10	71.11
11	160.00	11	71.11
12	160.00	12	71.11
13	160.00	13	71.11
14	160.00	14	71.11
15	160.00	15	71.11
16	160.00	16	71.11
17	160.00	17	71.11
18	160.00	18	71.11
19	160.00	19	71.11
20	160.00	20	71.11
21	160.00	21	71.11
22	160.00	22	71.11
23	160.00	23	71.11
24	160.00	24	71.11
25	160.00	25	71.11
26	160.00	26	71.11
27	165.54	27	74.19
28	166.81	28	74.89
29	166.74	29	74.86
30	166.74	30	74.86
31	166.74	31	74.86
32	166.74	32	74.86
33	166.74	33	74.86
34	166.74	34	74.86
35	166.74	35	74.86
36	166.74	36	74.86
37	166.74	37	74.86
38	166.74	38	74.86
39	166.74	39	74.86
40	166.74	40	74.86

T_s = 71.1°C (160°F) Condition

Node	Temp°F	Node	Temp°C
41	166.46	41	74.70
42	164.69	42	73.72
43	161.41	43	71.89
44	159.64	44	70.91
45	159.36	45	70.76
46	159.36	46	70.76
47	159.36	47	70.76
48	159.40	48	70.78
49	159.64	49	70.91
50	160.00	50	71.11
51	160.00	51	71.11
52	172.47	52	78.04
53	174.07	53	78.93
54	173.90	54	78.83
55	173.94	55	78.86
56	173.93	56	78.85
57	173.93	57	78.85
58	173.93	58	78.85
59	173.93	59	78.85
60	173.93	60	78.85
61	173.93	61	78.85
62	173.93	62	78.85
63	173.93	63	78.85
64	173.92	64	78.84
65	173.93	65	78.85
66	173.61	66	78.67
67	170.25	67	76.81
68	162.76	68	72.64
69	159.41	69	70.78
70	159.09	70	70.61
71	159.10	71	70.61
72	159.10	72	70.61
73	159.16	73	70.64
74	159.49	74	70.83
75	160.00	75	71.11
76	160.00	76	71.11
77	182.79	77	83.77
78	181.46	78	83.03
79	181.79	79	83.22
80	181.73	80	83.18

T_s = 71.1°C (160°F) Condition

Node	Temp°F	Node	Temp°C
81	181.74	81	83.19
82	181.74	82	83.19
83	181.74	83	83.19
84	181.74	84	83.19
85	181.74	85	83.19
86	181.74	86	83.19
87	181.74	87	83.19
88	181.74	88	83.19
89	181.74	89	83.19
90	181.70	90	83.17
91	181.74	91	83.19
92	177.82	92	81.01
93	163.27	93	72.93
94	159.36	94	70.76
95	159.40	95	70.78
96	159.35	96	70.75
97	159.36	97	70.76
98	159.40	98	70.78
99	159.64	99	70.91
100	160.00	100	71.11
101	190.00	101	87.78
102	190.00	102	87.78
103	190.00	103	87.78
104	190.00	104	87.78
105	190.00	105	87.78
106	190.00	106	87.78
107	190.00	107	87.78
108	190.00	108	87.78
109	190.00	109	87.78
110	190.00	110	87.78
111	190.00	111	87.78
112	190.00	112	87.78
113	190.00	113	87.78
114	190.00	114	87.78
115	190.00	115	87.78
116	190.00	116	87.78
117	190.00	117	87.78
118	160.00	118	71.11
119	160.00	119	71.11
120	160.00	120	71.11

T_s = 71.1°C (160°F) Condition

Node	Temp°F	Node	Temp°C
121	160.00	121	71.11
122	160.00	122	71.11
123	160.00	123	71.11
124	160.00	124	71.11
125	160.00	125	71.11
126	160.00	126	71.11
127	160.00	127	71.11
128	160.00	128	71.11
129	160.00	129	71.11
130	160.00	130	71.11
131	160.00	131	71.11
132	160.00	132	71.11
133	160.00	133	71.11
134	160.00	134	71.11
135	160.00	135	71.11
136	160.00	136	71.11
137	160.00	137	71.11
138	160.00	138	71.11
139	160.00	139	71.11
140	160.00	140	71.11
141	160.00	141	71.11
142	160.00	142	71.11

T_s = 82.2°C (180°F) Condition

Node	Temp°F	Node	Temp°C
1	180.00	1	82.22
2	180.00	2	82.22
3	180.00	3	82.22
4	180.00	4	82.22
5	180.00	5	82.22
6	180.00	6	82.22
7	180.00	7	82.22
8	180.00	8	82.22
9	180.00	9	82.22
10	180.00	10	82.22
11	180.00	11	82.22

T_s = 82.2°C (180°F) Condition

Node	Temp°F	Node	Temp°C
12	180.00	12	82.22
13	180.00	13	82.22
14	180.00	14	82.22
15	180.00	15	82.22
16	180.00	16	82.22
17	180.00	17	82.22
18	180.00	18	82.22
19	180.00	19	82.22
20	180.00	20	82.22
21	180.00	21	82.22
22	180.00	22	82.22
23	180.00	23	82.22
24	180.00	24	82.22
25	180.00	25	82.22
26	180.00	26	82.22
27	181.45	27	83.03
28	181.66	28	83.14
29	181.60	29	83.11
30	181.59	30	83.11
31	181.59	31	83.11
32	181.59	32	83.11
33	181.59	33	83.11
34	181.59	34	83.11
35	181.59	35	83.11
36	181.59	36	83.11
37	181.59	37	83.11
38	181.59	38	83.11
39	181.59	39	83.11
40	181.59	40	83.11
41	181.50	41	83.06
42	180.91	42	82.73
43	179.82	43	82.12
44	179.23	44	81.79
45	179.13	45	81.74
46	179.13	46	81.74
47	179.14	47	81.74
48	179.19	48	81.77
49	179.49	49	81.94
50	180.00	50	82.22
51	180.00	51	82.22

T_s = 82.2°C (180°F) Condition

Node	Temp°F	Node	Temp°C
52	183.60	52	84.22
53	183.83	53	84.35
54	183.71	54	84.28
55	183.72	55	84.29
56	183.71	56	84.28
57	183.72	57	84.29
58	183.72	58	84.29
59	183.72	59	84.29
60	183.72	60	84.29
61	183.72	61	84.29
62	183.72	62	84.29
63	183.72	63	84.29
64	183.71	64	84.28
65	183.71	65	84.28
66	183.61	66	84.23
67	182.49	67	83.61
68	180.00	68	82.22
69	178.88	69	81.60
70	178.78	70	81.54
71	178.78	71	81.54
72	178.78	72	81.54
73	178.86	73	81.59
74	179.28	74	81.82
75	180.00	75	82.22
76	180.00	76	82.22
77	187.20	77	86.22
78	186.54	78	85.86
79	186.61	79	85.89
80	186.59	80	85.88
81	186.59	81	85.88
82	186.59	82	85.88
83	186.59	83	85.88
84	186.59	84	85.88
85	186.59	85	85.88
86	186.59	86	85.88
87	186.59	87	85.88
88	186.59	88	85.88
89	186.59	89	85.88
90	186.58	90	85.88
91	186.59	91	85.88

T_s = 82.2°C (180°F) Condition

Node	Temp°F	Node	Temp°C
92	185.29	92	85.16
93	180.44	93	82.47
94	179.13	94	81.74
95	179.15	95	81.75
96	179.13	96	81.74
97	179.14	97	81.74
98	179.19	98	81.77
99	179.49	99	81.94
100	180.00	100	82.22
101	190.00	101	87.78
102	190.00	102	87.78
103	190.00	103	87.78
104	190.00	104	87.78
105	190.00	105	87.78
106	190.00	106	87.78
107	190.00	107	87.78
108	190.00	108	87.78
109	190.00	109	87.78
110	190.00	110	87.78
111	190.00	111	87.78
112	190.00	112	87.78
113	190.00	113	87.78
114	190.00	114	87.78
115	190.00	115	87.78
116	190.00	116	87.78
117	190.00	117	87.78
118	180.00	118	82.22
119	180.00	119	82.22
120	180.00	120	82.22
121	180.00	121	82.22
122	180.00	122	82.22
123	180.00	123	82.22
124	180.00	124	82.22
125	180.00	125	82.22
126	190.00	126	87.78
127	190.00	127	87.78
128	190.00	128	87.78
129	190.00	129	87.78
130	190.00	130	87.78
131	190.00	131	87.78

T_s = 82.2°C (180°F) Condition

Node	Temp°F	Node	Temp°C
132	190.00	132	87.78
133	190.00	133	87.78
134	190.00	134	87.78
135	190.00	135	87.78
136	190.00	136	87.78
137	190.00	137	87.78
138	190.00	138	87.78
139	190.00	139	87.78
140	190.00	140	87.78
141	190.00	141	87.78
142	190.00	142	87.78

T_s = 87.8°C (190°F) Condition

Node	Temp°F	Node	Temp°C
I	190.00	1	87.78
2	190.00	2	87.78
3	190.00	3	87.78
4	190.00	4	87.78
5	190.00	5	87.78
6	190.00	6	87.78
7	190.00	7	87.78
8	190.00	8	87.78
9	190.00	9	87.78
10	190.00	10	87.78
11	190.00	11	87.78
12	190.00	12	87.78
13	190.00	13	87.78
14	190.00	14	87.78
15	190.00	15	87.78
16	190.00	16	87.78
17	190.00	17	87.78
18	190.00	18	87.78
19	190.00	19	87.78
20	190.00	20	87.78
21	190.00	21	87.78
22	190.00	22	87.78
23	190.00	23	87.78

T_s = 87.8°C (190°F) Condition

Node	Temp°F	Node	Temp°C
24	190.00	24	87.78
25	190.00	25	87.78
26	190.00	26	87.78
27	189.44	27	87.47
28	189.12	28	87.29
29	189.07	29	87.26
30	189.06	30	87.26
31	189.06	31	87.26
32	189.06	32	87.26
33	189.06	33	87.26
34	189.06	34	87.26
35	189.06	35	87.26
36	189.06	36	87.26
37	189.06	37	87.26
38	189.06	38	87.26
39	189.06	39	87.26
40	189.06	40	87.26
41	189.06	41	87.26
42	189.06	42	87.26
43	189.06	43	87.26
44	189.06	44	87.26
45	189.06	45	87.26
46	189.06	46	87.26
47	189.07	47	87.26
48	189.12	48	87.29
49	189.44	49	87.47
50	190.00	50	87.78
51	190.00	51	87.78
52	189.21	52	87.34
53	188.76	53	87.09
54	188.68	54	87.04
55	188.67	55	87.04
56	188.67	56	87.04
57	188.67	57	87.04
58	188.67	58	87.04
59	188.67	59	87.04
60	188.67	60	87.04
61	188.67	61	87.04
62	188.67	62	87.04
63	188.67	63	87.04

T_s = 87.8°C (190°F) Condition

Node	Temp°F	Node	Temp°C
64	188.67	64	87.04
65	188.67	65	87.04
66	188.67	66	87.04
67	188.67	67	87.04
68	188.67	68	87.04
69	188.67	69	87.04
70	188.67	70	87.04
71	188.67	71	87.04
72	188.68	72	87.04
73	188.76	73	87.09
74	189.21	74	87.34
75	190.00	75	87.78
76	190.00	76	87.78
77	189.44	77	87.47
78	189.12	78	87.29
79	189.07	79	87.26
80	189.06	80	87.26
81	189.06	81	87.26
82	189.06	82	87.26
83	189.06	83	87.26
84	189.06	84	87.26
85	189.06	85	87.26
86	189.06	86	87.26
87	189.06	87	87.26
88	189.06	88	87.26
89	189.06	89	87.26
90	189.06	90	87.26
91	189.06	91	87.26
92	189.06	92	87.26
93	189.06	93	87.26
94	189.06	94	87.26
95	189.06	95	87.26
96	189.06	96	87.26
97	189.07	97	87.26
98	189.12	98	87.29
99	189.44	99	87.47
100	190.00	100	87.78
101	190.00	101	87.78
102	190.00	102	87.78
103	190.00	103	87.78

T_s = 87.8°C (190°F) Condition

Node	Temp°F	Node	Temp°C
104	190.00	104	87.78
105	190.00	105	87.78
106	190.00	106	87.78
107	190.00	107	87.78
108	190.00	108	87.78
109	190.00	109	87.78
110	190.00	110	87.78
111	190.00	111	87.78
112	190.00	112	87.78
113	190.00	113	87.78
114	190.00	114	87.78
115	190.00	115	87.78
116	190.00	116	87.78
117	190.00	117	87.78
118	190.00	118	87.78
119	190.00	119	87.78
120	190.00	120	87.78
121	190.00	121	87.78
122	190.00	122	87.78
123	190.00	123	87.78
124	190.00	124	87.78
125	190.00	125	87.78
126	190.00	126	87.78
127	190.00	127	87.78
128	190.00	128	87.78
129	190.00	129	87.78
130	190.00	130	87.78
131	190.00	131	87.78
132	190.00	132	87.78
133	190.00	133	87.78
134	190.00	134	87.78
135	190.00	135	87.78
136	190.00	136	87.78
137	190.00	137	87.78
138	190.00	138	87.78
139	190.00	139	87.78
140	190.00	140	87.78
141	190.00	141	87.78
142	190.00	142	87.78

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APPENDIX E

DATA FROM TUB EXPERIMENTS

Appendix E

Data from Tub Experiments

Tub Experiment No. 1

Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	26.34	26.54	27.23	26.05	26.05	26.00	25.80	26.09	26.53	27.26	26.28	27.16	26.26	26.33	26.24	26.82
15	25.85	26.39	27.23	25.85	25.95	35.89	25.95		26.83	27.11	26.09	27.21	26.33	26.48	26.24	26.48
30	26.00	26.54	27.13	26.05	26.05	79.45	29.72		26.87	27.11	30.19	27.16	29.54	26.48	26.33	26.62
45	25.85	26.49	44.88	26.09	29.27	86.33	94.92		44.85	27.02	94.30	33.76	68.38	26.48	29.34	33.76
60	25.90	26.83	48.68	27.52	32.24	86.75	92.73		48.43	27.02	91.92	39.57	84.93	29.24	32.64	38.93
75	26.34	27.38	51.07	29.17	34.33	59.34	90.38		50.82	27.41	92.11	42.67	89.72	30.84	35.20	40.58
90	26.78	28.27	53.64	30.93	36.84	65.11	88.84		51.42	28.10	91.98	44.30	92.23	32.09	36.45	42.67
105	27.42	29.73	55.80	32.75	39.24	61.58	88.96		54.51	28.95	92.35	46.74	94.46	35.20	38.50	45.57
120	28.37	31.08	55.16	35.01	41.71	61.43	88.84		55.40	29.75	91.24	50.99	95.85	37.87	40.37	48.71
135	29.52	32.39	54.52	37.26	41.93	63.44	87.92		56.73	30.79	91.81	54.95	96.52	39.79	41.86	51.23
150	30.86	33.77	54.17	39.08	42.90	66.12	87.73		58.74	31.84	91.37	57.99	97.13	41.60	43.43	53.10
165	31.88	34.96	54.47	40.48	45.10	67.24	86.88		59.56	33.10	90.75	59.56	97.29	42.83	45.13	54.17
180	33.42	36.21	54.56	42.02	47.14	68.23	86.61		61.51	34.41	90.82	62.17	97.36	44.28	47.16	55.93
195	34.29	37.37	55.22	43.59	47.54	69.09	85.77		61.72	35.55	90.57	62.89	96.87	45.76	48.34	57.42
210	35.33	38.38	56.06	45.19	49.71	69.85	85.11		62.33	36.75	90.88	63.35	96.70	47.05	49.95	58.07
225	36.32	39.45	56.31	46.58	50.19	71.20	85.23	44.30	63.25	37.90	91.86	63.97	96.48	48.40	51.08	58.42
240	37.56	40.25	57.91	47.82	51.33	76.01	84.10	45.97	63.20	39.02	93.28	62.99	96.10	49.68	52.23	57.97
255	38.91	41.21	59.44	49.19	52.10	84.26	83.98	47.48	62.33	39.98	93.04	61.82	95.88	50.94	53.29	56.82
270	40.04	42.13	59.79	50.52	53.31	85.11	83.57	48.45	61.92	41.04	93.60	60.45	95.01	52.42	54.70	56.22
285	41.00	43.10	60.30	51.48	53.60	86.61	83.27	49.81	61.97	41.95	93.85	59.59	94.15	53.33	55.53	55.98
300	41.92	44.04	60.21	52.93	54.25	89.29	83.33		62.39	42.82	94.13	59.05	93.32	54.77	57.34	56.05
315	42.57	45.09	60.47	54.15	55.08	90.10	83.75	51.78	62.70	43.58	93.88	58.70	92.78	56.15	58.70	55.66
330	43.36	46.09	61.02	55.53	55.87	90.22	84.04	53.03	63.57	44.58	93.76	58.55	92.27	57.14	59.82	55.85
345	44.15	46.93	61.43	56.77	57.12	90.28	84.57	53.81	64.35	45.55	93.70	58.80	91.90	58.24	60.67	56.05
360	44.87	47.89	62.61	57.77	58.79	89.91	84.63	55.63	64.66	46.44	93.07	59.10	91.65	59.46	61.68	56.30
375	45.47	49.01	62.76	58.89	59.65	90.58	84.99	56.82	65.55	47.33	93.45	59.71	91.65	60.47	62.34	56.89
390	46.03	50.11	63.17	59.96	60.97	90.65	85.11	58.06	66.06	48.01	93.70	60.17	91.65	61.48	63.47	57.44
405	46.76	51.01	63.07	60.97	61.07	90.46	85.35	58.99	66.76	48.86	93.32	60.22	91.65	62.19	64.19	58.04
420	47.51	51.76	63.45	62.01	62.17	90.42	85.43	60.04	66.94	49.67	93.28	60.64	91.55	62.83	65.10	58.62
435	48.25	52.72	63.92	62.78	63.51	90.36	85.85	60.89	67.37	50.57	93.47	60.80	91.68	63.86	65.89	59.43
450	48.76	53.39	63.66	63.45	64.49	90.30	85.91	61.55	67.80	51.19	93.28	60.95	91.55	64.48	66.47	60.04
465	49.56	54.08	63.87	64.13	65.02	90.30	85.91	62.37	68.17	51.99	93.47	61.15	91.92	65.21	67.37	60.44
480	50.33	54.76	64.23	64.96	65.49	90.00	85.85	63.20	68.54	52.52	93.28	61.60	91.98	65.73	67.85	61.35
495	50.94	55.30	64.49	65.66	65.81	89.63	86.21	63.82	68.87	53.24	92.97	61.81	91.86	66.57	68.65	61.81
510	51.52	56.15	64.39	66.33	66.65	89.50	85.97	64.60	69.19	53.87	92.79	62.06	91.74	67.10	69.19	62.37
525	52.04	56.64	64.44	66.92	67.24	89.38	86.21	65.23	69.57	54.45	92.48	62.52	91.92	67.80	69.89	63.03
540	52.43	57.15	64.40	67.42	67.56	88.86	86.25	65.72	69.48	54.89	91.98	62.22	91.43	67.92	70.02	63.36
555	53.01	57.66	64.56	67.95	67.85	88.49	86.19	66.30	69.75	55.38	91.67	62.48	91.16	68.62	70.29	63.97
570	53.35	58.21	64.77	68.44	68.44	88.55	85.83	67.04	70.13	56.02	91.24	62.84	90.78	69.10	71.10	64.13
585	53.89	58.77	65.24	68.87	69.25	88.19	85.88	67.52	70.56	56.47	91.12	63.35	90.51	69.43	71.58	64.70
600	54.47	59.13	65.56	69.36	69.52	87.94	86.01	67.95	70.77	56.92	90.88	64.85	90.33	69.97	72.29	65.22
615	54.87	59.53	65.77	69.85	70.07	87.88	85.77	68.28	71.31	57.57	90.27	66.01	90.21	70.29	72.40	65.69
630	55.31	60.10	65.77	70.23	70.12	87.52	85.83	68.82	71.42	57.87	90.39	66.80	90.09	70.61	72.73	65.90
645	55.71	60.45	65.77	70.50	70.55	87.46	85.53	69.14	71.53	58.32	90.09	66.91	90.15	70.99	73.22	66.43
660	56.02	60.57	65.74	70.85	70.85	87.01	85.39	69.44	71.88	58.96	89.91	66.82	89.91	71.44	73.68	66.99
675	56.47	61.03	65.74	71.07	71.50	86.95	85.39	69.82	71.99	59.42	89.84	66.19	89.68	71.82	74.12	67.41
690	56.92	61.23	65.27	71.56	71.61	86.89	85.33	70.10	71.88	59.93	89.47	64.78	89.41	72.20	74.34	67.89
705	57.37	61.59	64.74	71.72	71.77	86.83	85.03	70.36	71.93	60.53	89.35	63.59	89.17	72.37	74.51	68.16
720	57.88	62.00	63.96	72.10	71.99	86.65	85.21	70.47	72.10	61.09	89.05	62.92	88.92	72.84	74.79	68.64
735	58.13	62.10	63.54	72.37	72.21	86.59	85.03	70.85	71.61	61.34	88.80	63.48	88.62	73.02	75.29	69.07
750	58.43	62.41	63.23	72.48	72.54	86.59	84.91	71.17	71.82	61.59	88.50	63.59	88.37	73.13	75.82	69.40
765	58.69	62.61	63.26	72.70	72.76	86.29	84.85	71.45	71.99	62.15	88.19	63.64	88.19	73.35	75.82	69.67
780	58.90	82.68	62.88	72.89	72.94	86.02	84.88	71.69	71.90	62.27	87.90	63.65	87.74	73.70	75.70	69.83
795	59.11	62.99	62.68	73.11	73.00	85.84	84.58	71.79	72.12	62.78	87.92	63.24	87.44	73.65	75.93	70.01
810	59.36	63.30	62.47	73.33	73.26	85.72	84.53	72.07	72.12	62.98	87.50	63.24	87.26	74.09	76.15	70.07
825	59.52	63.40	61.96	73.50	73.50	85.72	84.58	72.34	72.12	63.09	87.26	63.03	87.01	74.03	76.43	70.28
840	59.77	63.56	61.65	73.72	73.83	85.54	84.53	72.62	72.06	63.29	86.83	63.24	86.77	74.37	76.43	70.55
855	60.03	63.87	61.86	73.94	73.72	85.36	84.35	72.67	72.28	63.50	86.55	63.65	86.47	74.59	76.60	70.82
870	60.06	63.92	61.86	74.16	73.88	85.18	84.23	72.84	72.06	63.60	86.35	63.60	86.29	74.75	76.77	70.87
885	60.23	64.18	62.06	74.27	74.11	85.06	83.93	72.89	72.39	63.81	86.23	64.17	86.11	74.64	77.11	71.19
900	60.28	64.14	61.35	74.19	74.08	84.46	83.74	73.03	72.20	63.71	85.82	63.45	85.58	74.62	76.78	70.90

Tub Expenment No. 2

Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	29.93	29.63	28.04	30.38	30.23	30.43	30.13	30.48	30.68	30.53	30.53	27 46	29 49	30.73	30.73	30 24
15	28.63	29.83	28.04	29.43	29.78	28.24	30.18	29.83	29.79	30.63	30.58	27.42	29.64	31.08	30.78	30.09
30	29.21	30.06	31.25	29.86	29.86	71.04	92.63	30.45	34.56	30.58	96.32	39.16	39.96	30.78	30.88	30.93
45	29.36	30.06	59.24	30.16	41.52	93.50	92.63	30.60	56.21	30.58	87.99	47.06	79.53	31.03	35.79	45.01
60	29.51	30.31	61.42	31.40	43.73	66.38	94.00	30.85	56.86	30.53	86.54	49.67	86.54	32.63	36.57	46.56
75	29.86	31.20	63.96	32.90	46.32	82.74	92.69	32.00	58 26	31.13	89.88	52.90	94.75	34.97	37 94	48.73
90	31.10	32.55	63.67	35.40	45.38	89.14	90.18	33.76	58.11	31.53	91.22	53.96	99.70	38.89	39.21	48.12
105	32.80	34.17	62.84	37.65	43.73	86.89	90.73	36.70	58.46	32.73	92.15	54.40	102.43	41.02	41.23	48.17
120	33.66	35.40	61.21	39.83	44.39	84.27	89.38	39.02	57.71	33.79	92.39	53.81	103.90	43.11	42.57	47 01
135	34.94	36.86	59.14	41.58	45.43	82.04	89.44	41.15	58.31	35.28	92.21	54.45	104.87	44.52	44 52	48.64
150	36.13	38.22	57.43	43.40	46.87	80.36	88.44	42.91	58.80	36.51	91.90	55.81	105.26	46.00	45.86	49.79
165	37.22	39.34	55.69	44.93	48.16	79.04	86.87	44.60	58.60	37.61	92.45	56.84	105.09	47.62	47.45	50.78
180	38.28	40.46	54.41	46.14	49.83	78.24	86.39	45.86	59.41	38.72	92.70	57.49	104.92	48.52	48.46	51.83
195	39.39	41.36	53.15	47.76	50.34	78.46	84.66	47.20	59.20	39.89	92.89	57.94	104.52	49.78	50.03	52.98
210	40.14	42.21	52.34	49.01	51.77	80.19	84.78	48.33	59.71	40.85	93.01	58.50	104.01	50.64	50.97	53.90
225	40.72	43.02	51.72	50.16	52.77	84.19	83.95	49.41	59.97	41.96	93.14	59.00	103.55	51.49	52.30	54.97
240	41.36	44.00	51.24	51.48	53.64	86.99	83.54	50.44	60.82	43.20	93.14	59.00	103.10	52.54	53.41	55.80
255	42.00	44.93	50.72	52.87	54.61	87.59	83.66	51.81	61.02	44.18	93.14	59.41	102.25	53.75	54.28	56.40
270	42.49	45.66	49.94	53.77	55.28	85.50	83.84	52.75	61.65	45.18	92.86	59.63	101.45	54.59	55.22	57.06
285	43.08	46.38	49.75	54.89	56.37	86.40	84.01	54.01	62.05	46.01	92.93	59.98	100.84	55.67	56.06	57.56
300	43.95	47.11	49.56	55.78	57.37	87.60	83.84	55.04	62.62	46.90	93.05	60.03	100.39	56.81	57.26	58.11
315	44.77	47.95	49.71	56.87	58.38	88.33	83.49	55.98	63.13	47 60	92.37	59.93	99.78	57.71	58.06	59.12
330	45.49	48.91	49.94	57.92	59.49	88.64	83.19	56.92	63.54	48.71	92.31	59.78	99.33	58.66	58.76	59.83
345	46.32	49.51	50.28	58.78	60.40	88.46	83.84	57.97	63.95	49.56	92.62	60.08	99.05	59.52	59.68	60.38
360	46.94	50.32	50.70	59.64	61.16	88.09	83.66	58.68	64.32	50.32	92.93	60.33	98.61	60.59	60.59	61.24
375	47.61	50.94	51.08	60.61	62.03	87.60	84.49	59.44	64.99	51.17	92.43	60.64	98.11	61.49	60.99	61.55
390	48.41	51.69	51.50	61.21	62.53	87.73	84.37	60.30	55 46	52.04	92.29	61.19	97.65	62.21	61.80	62.26
405	49.15	52.32	51.79	62.02	63.25	87.91	83.78	61.11	66.09	52.81	92.60	61.50	96.94	63.08	62.46	62.62
420	49.80	53.18	52.36	62.84	63.93	87.85	84.55	61.72	66.46	53.19	92.60	61.75	96.07	63.85	63.28	63.13
435	50.48	53.86	52.60	63.51	64.39	87.42	84.19	62.48	66.78	53.82	93.03	62.21	95.31	64.47	63.70	63.70
450	51.08	55.83	53.09	64.18	65.28			63.56	68.06	54.60		63.18	94.50	65.15	64.21	64.47
465	51.65	56.57	53.43	64.86	66.07			64.18	68.81	55.18		63.44	94.09	65.78	64.53	64.94
480	52.17	55.82	53.67	65.44	66.28	85.26	84.73	64.60	68.06	55.92	92.60	64.11	93.65	66.41	64.84	64.89
495	52.60	56.17	53.86	66.02	66.92	87.36	84.67	65.23	68.38	56.27	91.25	64.21	93.22	66.89	65.36	65.83
510	53.25	56.78	54.22	66.82	67.35	87.79	85.68	65.82	68.71	56.93	91.37	64.85	93.09	67.54	66.16	66.42
525	53.74	57.43	54.32	67.25	67.94	87.91	85.32	66.35	69.58	57.43	90.82	65.06	92.54	68.18	66.16	66.95
540	54.08	57.89	54.37	67.83	68.37	88.28	85.68	66.77	70.06	57.98	90.69	65.74	92.29	68.55	66.42	67.32
555	54 56	59.71	54.27	68.26	69.07			67.78	71.24	58.58		67.27	92.04	68.93	67.06	67.64
570	55.10	60.12	53.93	68.75	69.67			68.32	71.41	59.04		69.47	92.04	69.63	67.80	68.02
585	55.45	60.57	55.69	69.23	69.94			68.75	71.30	59.44		65.43	91.98	69.85	67.91	68.07
600	56.14	60.77	57.43	69.78	70.64			69.18	71.62	59.95		64.96	91.61	70.44	67.86	67.91
615	56.64	61.28	58.19	70.10	71.18			69.61	71.84	60 30		66 53	91.31	70.87	67.96	67 54
630	57.14	61.99	57.44	70.59	71.50			70.26	71.90	60.65		67.86	91.20	71.41	68.34	6" 91
645	57.44	62.45	57.84	70.86	71.56			70.64	72.06	60.96		67.33	90.84	71.46	68.88	68.07
660	57.69	62.60	59.15	71.34	72.05			71.02	72.28	61.46		65.95	90.71	72.12	69.04	68.23
675	58.24	63.07	60.22	71.72	72.65			71 34	72.60	62.02		65.79	90.41	72.55	69.15	68.34
690	58.70	62.14	60.47	72.26	72.70	87.06	85.68	71.34	72.01	62.17	89.96	65.95	90.35	72.88	69.53	68.77
705	58.90	62.50	59.77	72.43	72.75	87.00	85.09	71.61	72.17	62.48	89.43	66.85	90.05	73.10	69.31	69.04
720	59.26	62.81	59.61	72.86	73.14	87.24	84.85	71.94	72.28	62.89	89.43	67.33	89.98	73.43	69.85	69.80
735	59.61	63.22	59.56	73.03	73.41	86.88	84.55	72.37	72.12	63.25	89.31	67.38	89.86	73.70	69.74	70.55
750	59.99	63.44	59.88	73.30	73.74	87.05	84.98	72.70	72.17	53.62	89.29	66.96	90.09	73.92	70.50	70.98
765	60.39	63.90	59.42	73.59	73.98	86.87	84.90	72.87	72.28	63.83	89.23	67.07	89.66	74.20	70.66	71.47
780	60.54	64.06	59.93	73.74	74.08	87.05	84.78	73.19	72.34	64 08	89.17	66.12	89.60	74.25	71.15	71.74
795	60.84	64.32	60.44	73.98	74.41	86.93	84.48	73.30	72.28	64.50	89.11	66.12	89.60	74.59	70.61	71.47
810	61.04	64 53	59.99	74.24	74.80	86.99	84.37	73.63	72.72	64.66	88.99	66.33	89.42	74.75	70.77	71.96
825	61.29	64.84	59.88	74.30	74.80	86.57	84.25	73.69	72.61	64.86	89.05	66.28	89.48	74.92	70.72	72.17
840	61.50	64.99	58.22	74.63	74.98	86.63	84.25	73.96	72.88	65.07	88.80	66.59	89.17	75.14	71.20	72.28
855	61.75	65.31	58.77	74.80	75.24	86.27	84.48	74.19	72.83	65.33	88.68	66.33	89.23	75.20	71.85	72.28
870	61.97	65.38	58.52	74.87	75.15	86.12	84.16	74.37	72.47	65.34	88.27	66.24	88.57	75.18	70.85	72.15
885	62.27	65.53	57.92	75.04	75.38	86.06	84.04	74.49	72.91	65.55	88 21	66.24	88.45	75.34	71.66	72.31
900	62.38	65.74	57.72	75.21	75.49	85.88	83.93	74.54	72.47	65.66	87 84	65.97	88.57	75.34	71 17	72.31

Tub Expenment No. 3

Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	24.86	26.02	27.09	25.29	25.63	25.29	24.86	25.53	25.16	26.18	25.16	25.11	25.55	25.59	25.26	25.93
15	25.20	25.92	27.23	25.29	25.44	25.63	25.39	25.53	25.40	26.22	25.88	25.88	25.40	25.50	25.21	25.64
30	25.24	25.87	28.57	25.20	25.34	83.30	94.38	25.44	30.52	26.22	95.60	28.98	48.15	25.55	25.30	25.69
45	25.15	26.26	59.46	25.53	39.36	86.13	95.41	25.34	57.01	26.03	93.39	51.83	79.05	26.47	29.03	36.73
60	25.15	26.60	63.99	26.75	44.29	71.28	93.17	26.07	60.44	26.13	91.59	51 60	84.15	28.13	31.47	40.34
75	25.73	27.87	66.29	26.57	48.58	91.75	92.12	27.09	62.72	26.56	93.89	56.66	87 50	31.12	33.48	41.02
90	26.40	29.11	69.12	30.80	48.47	90.83	91.32	29.16	63.49	27.15	93.08	59.17	90.98	34 09	36.99	41.24
105	27.28	30.56	70.53	33.36	50.87	90.52	90.69	31.90	65.10	28.23	93.70	61.04	93.51	37 46	39.43	41 66
120	28.89	32.22	71.44	36.10	54.63	90.56	89.95	35.02	66.11	29.88	92.76	62.79	95.36	40.15	42.16	42.81
135	30.08	33.74	72.58	36.36	53.66	90.68	89.71	37.51	67.59	31.41	92.94	64.13	96.06	41.84	43.84	44.11
150	31.12	35.12	74.22	40.59	52.84	90.50	88.79	39.58	68.82	32.92	92.88	66.05	96.06	44.05	46.14	45.53
165	32.42	36.47	73.45	42.46	52.70	89.83	88.48	41.81	68.39	34.29	92.51	67.00	94.98	45.70	48.43	46.42
180	33.58	37.83	73.23	44.41	52.79	89.77	87.81	43.59	69.03	35.52	92.08	66.69	93.81	47.37	50.18	47.37
195	34.55	39.15	73.29	45.73	52.75	89.95	87.75	45.12	69.52	36.71	91.16	66.63	92.82	48.55	51.36	48.49
210	35.63	40.22	72.91	47.57	52.79	89.83	87.45	46.62	69.14	37.86	90.25	66.58	92.26	50.13	52.84	50.04
225	36.73	41.39	72.80	48.96	54.78	90.01	87.51	48.19	69.90	38.03	90.06	66.21	91.40	51.40	53.85	51.17
240	37.45	42.29	73.17	50.30	56.29	90.14	87.15	49.32	70.21	39.92	91.31	65.94	90.76	52.61	53.96	51.70
255	38.51	43.69	72.90	51.83	57.79	89.71	87.82	50.87	70.59	40.98	92.05	65.67	90.70	54.06	55.08	52.47
270	39.52	44.73	73.17	52.92	58.29	89.71	87.88	52.20	71.07	41.94	92.35	65.67	91.25	55.18	55.77	53.28
285	40.53	45.67	72.63	54.13	60.16	88.79	88.42	53.31	70.91	43.07	92.66	65.67	91.06	56.42	56.51	53.87
300	41.27	46.76	71.86	55.30	60.47	89.22	87.94	54.52	71.29	43.88	92.35	67.05	90.82	57.31	57.31	54.89
315	42.18	47.68	72.19	56.39	61.07	89.10	88.24	55.60	71.56	44.87	91.98	67.52	90.70	58.31	58.16	55.48
330	43.04	48.70	72.19	57.44	62.24	88.30	88.67	56.54	71.77	45.75	92.29	66.68	90.33	59.48	58.67	56.22
345	43.97	49.54	71.86	58.39	62.44	87.21	90.02	57.59	71.72	46.69	92.17	65.67	90.58	60.29	59.78	57.01
360	44.66	50.25	72.29	59.39	63.61	88.22	88.71	58.63	72.42	47.52	92.17	65.19	91.07	61.08	60.22	58.05
375	45.43	51.24	72.45	60.31	64.91	88.59	88.89	59.65	73.18	48.31	91.62	65.14	90.76	62.14	60.83	58.75
390	46.15	52.05	73.05	61.31	65.38	88.41	89.14	60.51	73.57	49.16	90.76	66.50	90.39	63.07	61.38	59.67
405	46.88	52.72	72.89	62.07	65.33	89.20	88.83	61.47	73.73	49.88	90.52	65.56	90.45	63.73	62.09	60.47
420	47.78	53.35	73.10	62.94	65.64	89.20	89.38	62.33	74.12	50.83	89.60	67.30	90.15	64.62	63.01	61.23
435	48.40	53.93	73.49	63.72	67.07	89.26	90.06	63.10	74.67	51.44	88.86	68.31	89.84	65.29	63.63	61.99
450	49.14	54.76	73.82	64.50	67.76	89.32	90.24	63.77	75.01	52.11	88.37	68.31	89.60	66.19	64.30	62.50
465	49.92	55.39	73.43	65.38	68.62	89.57	89.38	64.44	75.06	52.69	89.11	66.87	89.41	66.82	64.56	62.81
480	50.68	56.20	73.13	66.08	69.40	89.48	90.04	65.03	75.14	53.49	88.27	66.37	89.37	67.59	65.21	63.81
495	51.44	56.84	72.97	66.67	69.34	89.85	90.58	65.72	75.31	54.16	88.15	66.00	89.37	68.02	65.95	64.59
510	52.25	57.49	73.63	67.46	69.77	89.85	90.34	66.45	75.64	54.65	88.27	67.00	89.37	68.71	66.63	65.27
525	53.12	58.20	73.57	67.84	70.58	89.91	90.16	66.93	75.92	55.24	88.15	67.86	89.31	69.31	66.85	66.00
540	54.04	58.70	73.79	68.42	70.98	89.38	90.89	67.46	76.20	55.83	88.15	68.12	89.13	69.85	67.75	66.32
555	54.67	59.21	73.68	69.02	71.44	89.05	90.58	68.10	76.54	56.42	88.51	67.70	89.13	70.39	68.23	66.85
570	55.31	59.92	73.98	69.61	72.26	89.11	90.71	68.59	76.43	56.92	88.33	68.88	89.13	70.76	68.12	67.18
585	55.80	60.37	73.46	70.10	72.20	88.99	90.52	69.12	77.05	57.27	88.51	67.80	88.94	71.14	68.88	67.75
600	56.22	60.75	73.81	70.55	72.44	89.02	90.73	69.58	77.07	57.74	88.35	69.98	88.96	71.65	68.79	68.36
615	56.81	61.25	74.20	71.09	72.88	88.95	90.85	69.90	77.41	58.24	88.29	70.19	88.84	72.19	69.82	68.41
630	57.38	61.45	74.20	71.46	72.99	88.95	92.02	70.44	77.69	58.64	88.29	71.21	88.72	72.57	69.60	68.88
645	57.86	62.11	73.43	72.01	73.21	88.71	92.45	70.98	77.75	58.90	88.17	68.47	88.66	72.95	69.87	69.60
660	58.27	62.47	73.76	72.28	73.54	89.02	90.97	71.25	77.98	59.40	88.23	71.00	88.66	73.12	70.41	70.03
675	58.67	62.88	74.03	72.66	73.87	88.55	91.03	71.52	78.26	59.91	88.17	72.02	88.54	73.94	70.89	70.03
690	59.13	63.34	73.92	73.10	74.09	88.22	91.28	71.90	78.55	60.22	88.05	72.84	88.54	74.00	71.27	70.41
705	59.53	63.65	73.76	73.43	74.36	89.14	91.16	72.28	78.32	60.57	88.35	73.06	88.42	74.49	71.27	70.78
720	59.75	63.93	73.67	73.78	74.56	88.50	91.50	72.68	78.68	60.99	88.25	73.35	88.43	74.79	71.45	71.18
735	60.21	64.34	73.73	74.06	74.67	88.32	91.19	72.96	78.51	61.35	88.07	73.52	88.43	75.18	71.50	71 23
750	60.46	64 55	73.45	74.39	74.95	88.44	90.52	73.29	78.85	61.55	88.01	72.53	88.25	75.29	72.04	71.34
765	60.71	64.86	74.06	74.72	75.22	87.77	91.13	73.51	78.91	61.85	87.76	73.63	87.95	75.68	72.26	71.02
780	61.06	64.97	73.34	74.95	75.50	88.20	90.64	73.78	78.80	62.26	87.58	72.97	88.01	75.91	72.26	71.83
795	61.37	65.28	72.08	75.17	75.67	88.32	89.73	73.95	78.51	62.57	87 58	70.37	88.01	76.13	73.52	71.40
810	61.57	65.60	72.25	75.45	75.78	87.95	90.52	74.33	78.05	62.82	87 16	70.91	87.58	76.41	72.75	72.75
825	61.72	65.78	71.65	75.45	76.06	88.38	89.48	74.50	77.94	63.13	87 16	70.00	87.40	76.58	73.41	73.52
840	61.98	65.97	69.58	75.74	76.19	87.49	89.57	74.62	77.50	63.39	86.94	69 95	87.18	76.65	72.98	73.20
855	62.06	66.29	67.83	75.80	76.30	87.49	88.34	74.85	77.27	63.44	87.06	70.33	87.12	76.88	73.97	73.92
870	62.34	66.45	66.87	76.08	76.36	87.07	89.01	75.01	77.10	63.75	86.82	70.76	87.00	76.76	74 08	74 25
885	62.49	66.50	65.92	76.19	76.41	86.88	88.89	75.07	76.88	63.91	86.52	71.03	86.64	77.10	72.98	74.69
900	62.75	66.55	66.06	76.41	76.53	87.25	87.98	75.29	77 38	64.32	86 10	70.33	86.52	77.21	73.59	75.08

Tub Experiment No. 4

Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	27.48	26.21	25.04	26.35	25.91	69.01	42.65	26.55	28.02	27.04	34.22	26.41	31.84	26.90	25.97	24.53
15	27.48	26.40	26.84	26.50	25.96	87.08	91.67	26.50	31.39	27.29	87.08	27.53	50.72	27.53	25.83	25.64
30	69.80	26.64	40.24	29.08	85.70	92.04	91.17	26.79	50.02	27.34	90.01	58.63	79.59	37.90	29.71	36.48
45	58.96	28.07	42.81	32.21	45.33	88.35	88.11	29.06	53.68	27.97	90.86	58.07	83.28	40.71	33.68	42.20
60	50.92	29.31	43.90	33.63	39.92	80.88	81.34	31.26	50.91	28.96	91.28	57.32	84.75	39.22	35.71	43.82
75	45.72	30.36	45.44	34.30	40.14	75.57	79.15	32.97	54.51	30.11	92.58	61.55	85.84	38.16	38.27	46.07
90	41.95	31.81	47.45	35.59	42.59	75.35	79.67	34.24	57.87	31.10	92.51	67.15	87.08	38.00	40.82	47.97
105	39.44	32.72	48.87	37.10	43.35	76.47	80.02	35.64	58.98	31.89	91.65	68.38	87.56	39.38	43.23	48.59
120	38.26	33.53	50.07	38.37	42.59	76.58	81.69	37.26	59.59	33.15	89.39	67.36	88.05	40.45	44.80	49.27
135	51.44	34.40	52.11	40.03	45.99	77.72	82.45	39.33	60.85	34.47	90.07	66.20	88.23	43.44	46.18	48.20
150	65.49	35.48	53.12	42.18	48.47	79.91	83.68	41.47	63.24	35.50	89.64	65.47	88.78	49.16	46.91	47.75
165	62.27	36.79	55.47	44.12	50.07	80.88	85.04	44.39	62.11	39.28	89.45	64.84	89.27	51.62	48.37	47.07
180	55.82	38.05	58.01	46.86	52.88	84.80	85.10	46.16	63.44	41.51	88.90	63.49	90.01	50.91	49.97	47.41
195	51.63	39.28	54.58	48.13	52.26	86.05	84.68	47.45	61.81	41.24	89.08	62.32	90.43	50.44	51.96	50.63
210	48.79	40.11	53.00	49.85	52.66	86.64	84.54	48.62	60.92	41.49	88.58	61.99	90.29	51.31	52.50	53.03
225	47.15	41.07	51.80	50.94	52.37	86.70	83.95	49.71	61.07	41.91	89.37	62.19	90.17	52.41	53.71	55.31
240	48.14	42.14	50.89	51.80	53.10	86.22	83.72	50.80	61.02	42.77	89.31	62.75	89.66	53.08	55.12	57.29
255	45.58	43.01	49.85	52.76	53.39	89.01	79.42	51.61	61.38	43.48	90.05	63.68	89.50	54.09	56.20	58.50
270	45.47	43.83	49.08	53.63	54.31	90.97	77.13	52.57	65.13	44.24	90.78	65.02	89.25	55.12	57.14	59.36
285	45.42	44.70	48.79	54.51	55.29	86.10	83.07	53.29	62.09	45.06	89.80	65.23	89.31	56.05	58.35	60.22
300	45.75	46.31	48.73	55.69	56.53			54.60	67.50	46.05		65.86	88.95	57.10	59.31	60.47
315	46.03	46.36	48.82	56.33	56.93	87.48	82.14	55.59	62.96	46.83	90.29	65.13	88.88	57.95	60.32	60.62
330	46.71	47.27	49.02	57.76	58.11	87.77	83.35	56.71	64.11	47.90	90.33	64.89	89.29	58.98	61.86	60.55
345	47.04	47.94	49.06	58.57	58.97	87.16	82.53	57.96	64.06	48.58	90.09	64.16	89.48	59.89	62.42	60.55
360	47.61	48.74	49.06	59.48	59.79	87.77	84.00	58.72	64.01	49.66	90.15	63.85	90.33	60.45	63.29	60.80
375	48.23	49.25	48.97	60.24	60.45	87.59	83.71	59.69	64.37	50.41	90.15	63.49	91.06	61.40	64.21	61.20
390	48.74	50.13	48.79	61.05	61.30	87.22	83.35	60.60	64.56	51.16	90.03	63.49	91.49	62.21	64.89	61.71
405	49.25	50.74	49.46	61.86	62.12	87.04	84.29	61.41	65.04	51.92	90.15	63.03	91.43	62.93	65.67	61.91
420	49.89	51.45	50.74	62.83	62.78	87.77	84.41	62.27	65.36	52.54	90.33	62.52	91.18	64.01	66.58	61.81
435	50.46	52.07	51.12	63.50	63.76	87.71	84.59	62.94	65.83	53.16	90.39	62.26	91.00	64.78	67.30	62.16
450	50.69	52.41	50.54	63.94	63.99	87.85	84.25	63.32	66.06	53.75	89.68	62.39	90.64	65.28	67.70	62.44
465	51.30	53.03	50.31	64.77	64.67	86.94	84.31	63.99	66.38	54.24	89.23	62.85	90.64	65.75	68.13	63.05
480	51.73	53.52	49.98	65.14	65.09	87.06	85.08	64.72	66.49	54.82	89.11	63.41	90.52	66.38	68.88	63.48
495	52.26	54.10	50.07	65.88	65.72	88.21	84.78	65.45	66.86	55.41	88.86	63.77	90.45	66.86	69.53	63.88
510	52.79	54.69	50.26	66.35	66.19	87.60	85.20	65.93	67.23	55.90	88.68	64.19	90.27	67.49	70.18	64.55
525	53.23	55.18	50.69	66.88	66.72	87.36	84.66	66.51	67.86	56.59	88.26	64.65	89.97	67.92	70.50	65.12
540	53.71	55.53	51.26	67.36	67.20	87.38	84.60	66.99	68.19	57.04	88.07	64.76	89.66	68.40	71.04	65.38
555	54.10	56.12	52.79	67.90	67.63	86.94	85.50	67.26	68.29	57.44	87.71	64.44	89.72	68.04	71.31	65.43
570	54.75	56.78	53.38	68.53	68.37	86.84	85.64	67.94	68.61	58.29	87.75	64.44	89.70	69.47	71.89	66.16
585	55.24	57.22	53.14	68.80	68.91	87.20	85.28	68.43	68.77	58.59	87.45	64.85	89.76	70.01	72.32	66.56
600	55.54	57.83	53.43	69.34	69.18	86.48	85.94	68.80	69.09	59.15	87.26	65.22	89.58	70.33	72.59	66.53
615	55.88	57.93	53.87	69.83	69.51	86.12	85.88	69.40	69.41	59.45	87.02	65.27	89.27	70.86	72.92	66.95
630	56.18	58.33	53.97	70.32	69.94	86.84	85.82	69.67	69.52	59.86	86.96	65.22	89.09	71.03	73.25	67.48
645	56.58	58.74	54.85	70.48	70.37	86.30	86.90	70.05	69.63	60.36	86.42	65.58	88.96	71.51	73.74	67.80
660	56.88	59.09	54.60	70.84	70.75	86.06	86.96	70.37	69.95	60.71	86.00	65.64	88.60	71.67	74.02	68.07
675	57.22	59.35	54.36	71.02	71.02	85.58	86.90	70.75	70.22	60.91	86.06	65.90	88.23	72.11	74.35	68.55
690	57.30	59.43	54.43	70.91	71.07	85.61	86.27	70.80	70.01	61.26	85.66	66.10	88.01	72.27	74.24	68.82
705	57.71	59.84	54.28	71.24	71.40	85.19	86.51	71.13	70.22	61.41	85.72	66.10	87.83	72.49	74.63	68.82
720	57.86	60.09	54.33	71.62	71.62	84.69	86.81	71.40	70.38	61.76	85.42	66.32	87.46	72.92	74.57	69.09
735	58.21	60.40	54.28	71.73	71.89	85.37	86.39	71.73	70.54	62.07	85.24	66.37	87.34	73.14	74.96	69.52
750	58.56	60.50	54.53	71.94	71.94	84.42	86.15	71.94	70.60	62.37	85.30	66.63	87.04	73.53	75.30	69.95
765	58.77	60.80	54.28	72.27	72.38	84.00	86.21	72.11	70.81	62.53	85.13	66.32	86.92	73.53	75.30	70.06
780	58.82	61.05	54.04	72.43	72.60	83.47	86.21	72.27	70.92	62.83	85.07	66.42	86.62	73.80	75.74	70.11
795	59.17	61.36	53.94	72.78	72.71	83.00	86.75	72.54	71.08	63.19	84.83	66.32	86.20	74.13	75.97	70.60
810	59.58	61.71	54.14	73.12	73.17	82.90	86.88	72.84	71.06	63.33	84.69	66.40	86.00	74.39	75.95	70.85
825	59.83	61.86	53.94	73.28	73.39	83.13	86.64	73.01	71.01	63.43	84.46	66.35	85.82	74.44	76.17	71.01
840	59.99	62.16	53.90	73.39	73.61	82.72	86.48	73.39	71.11	63.64	84.40	66.14	85.52	74.61	76.40	71.01
855	60.29	62.37	53.85	73.72	73.67	82.66	86.70	73.67	71.33	63.90	84.22	66.09	85.17	74.67	76.40	71.22
870	60.49	62.57	53.80	73.89	73.89	82.49	86.52	73.67	71.06	64.15	83.98	66.09	84.99	75.05	76.57	71.28
885	60.54	62.68	53.51	74.00	74.11	82.31	86.22	73.83	71.28	64.41	83.93	65.93	84.75	75.05	76.85	71.55
900	60.69	62.82	53.56	74.22	74.17	82.14	85.92	74.00	71.33	64.47	83.75	65.51	84.69	75.17	76.90	71.44

Tub Experiment No. 5

Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	29.42	30.52	25.39	30.97	30.87	31.12	30.62	31.22	30.85	31.25	31.89	27.54	32.29	31.35	31.84	28.82
15	27.83	30.47	27.73	30.17	30.72			30.12	32.24	31.55		27.89	31.80	31.84	31.84	29.32
30	28.32	30.67	39.03	29.82	30.87	95.39	90.60	30.72	45.49	31.25	94.42	46.71	82.35	31.79	33.35	41.22
45	28.82	30.77	38.26	31.12	35.39	93.51	89.07	31.52	53.20	31.30	92.31	56.03	80.82	34.72	36.94	45.60
60	29.22	31.32	39.19	32.83	35.50	91.15	88.27	33.80	53.59	31.94	92.92	57.56	85.28	35.39	39.42	47.10
75	29.82	32.12	40.52	34.72	36.23	90.42	85.85	35.08	52.29	32.69	93.54	58.16	86.83	37.41	41.65	48.67
90	30.72	32.98	42.02	36.91	39.73	90.46	83.18	36.33	53.88	33.50	93.48	60.13	87.73	39.18	43.47	51 25
105	31.82	34.21	43.37	38.97	43.48	90.30	82.80	37.86	55.14	34.47	92.92	62.55	88.16	41.38	45.96	53.35
120	32.51	35.37	44.36	40.93	45.00	90.16	81.94	39.76	56.55	35.42	93.09	64.64	88.62	43.72	47.81	55.37
135	33.83	36.52	45.39	42.97	46.39	90.16	81.70	41.95	58.60	36.93	92.66	66.95	89.23	45.64	49.56	57 69
150	35.01	37.69	46.11	45.17	48.25	90.28	80.78	44.06	80.06	38.13	92.10	67.10	89.84	47.36	51.70	59.20
165	35.84	39.01	46.78	47.17	50.67	90.03	82.05	46.16	62.28	39.51	91.49	67.79	90.27	48.93	53.33	60.76
180	36.99	40.14	47.12	51.19	51.24	89.79	82.11	48.02	63.25	40.89	91.43	68.81	90.51	50.99	54.34	61.82
195	38.16	41.52	48.02	53.75	52.68	90.28	82.23	49.67	65.01	42.27	90.70	69.24	90.82	52.61	55.91	63.15
210	39.33	42.76	48.87	54.87	54.33	90.56	82.46	51.19	66.52	43.56	90.76	69.19	91.18	53.91	57.84	63.76
225	40.40	43.74	50.06	54.87	55.31	91.01	82.40	53.07	68.17	45.03	91.00	72.15	91.18	55.66	59.45	64.33
240	41.76	45.13	51.60	57.06	57.28	90.95	84.17	54.70	68.45	46.09	90.27	72.55	91.00	57.19	60.67	65.28
255	42.89	46.29	52.57	61.12	58.29	89.79	83.99	56.13	69.64	47.32	90.09	73.76	91.24	58.29	61.73	66.12
270	43.70	47.42	53.73	62.09	59.61	90.89	85.18	57.58	70.50	48.50	90.51	74.03	91.55	59.71	63.36	66.96
285	44.69	48.38	54.51	63.22	60.92	90.03	85.42	58.79	71.58	49.64	91.12	74.58	91.49	60.97	64.34	68.08
300	45.57	49.61	56.28	62.96	63.22	89.42	86.68	60.12	71.90	50 74	91.00	74.47	91.73	62.29	65.23	68.29
315	46.35	50.61	58.64	63.53	64.05	89.54	87.28	61.33	72.66	51.79	90.82	74.58	91.80	63.41	66.22	68.58
330	47.25	51.56	61.12	64.20	65.35	90.77	87.83	62.24	73.15	52.70	90.94	74.42	91.86	64.60	66.91	68.83
345	47.98	52.81	64.05	64.99	66.33	91.26	87.71	63.27	73.70	53.71	90.82	74.86	91.67	65.49	68.08	69.21
360	48.71	53.15	64.44	65.86	67.99	91.36	87.62	63.87	74.63	54.42	90.82	75.52	91.73	66.26	68.76	69.52
375	49.61	54.03	66.98	67.14	68.70	91.61	87.92	64.92	75.58	55.20	90.88	75.97	91.80	67.43	69.41	70.01
390	50.42	54.96	68.28	67.78	69.62	91.48	88.35	65.86	76.25	56.03	91.00	76.25	91.80	68.34	70.38	70.54
405	51.18	55.80	69.67	68.43	71.84	91.30	88.66	66.55	77.15	56.88	91.12	76.98	91.80	69.20	71.13	71.08
420	52.09	56.49	72.17	69.24	70.75	91.18	89.27	67.46	78.29	57.68	91.24	76.98	91.80	70.11	71.84	71.67
435	52.78	57.35	72.93	69.78	71.78	91.24	89.15	68.21	79.03	58.33	91.18	77.89	91.92	70.86	72.76	72.11
450	53.49	58.00	74.09	70.11	72.38	90.87	89.70	69.02	80.01	59.09	91.24	78.69	91.98	71.46	73.53	72.98
465	54.07	58.96	75.26	71.08	73.76	91.11	90.14	69.84	80.41	59.85	91.49	79.43	91.98	72.38	74.08	73.53
480	55.01	59.87	75.79	71.92	74.34	91.24	90.57	70.73	81.01	60.49	91.45	80.04	92.00	72.90	74.44	74.33
495	55.60	60.43	75.79	72.69	74.40	90.93	90.93	71.32	81.47	61.24	91.76	80.72	92.07	73.56	75.05	75.16
510	56.25	61.04	76.81	73.24	74.40	90.87	91.30	71.81	81.82	61.80	91.88	81.01	92.50	74.39	75.77	75.38
525	56.69	61.75	76.02	73.79	75.29	90.69	91.79	72.52	81.64	62.62	91.94	81.13	92.50	74.66	76.33	76.00
540	57.44	62.47	75.51	74.17	75.62	91.06	92.47	73.18	81.53	63.28	92.00	81.18	92.58	75.38	77.01	76.11
555	57.85	62.83	75.23	74 79	75.79	90.51	92.17	73.79	81.76	63.64	91.88	81.41	92.74	76.05	77.35	76.56
570	58.55	63.39	74.40	75.51	76.47	90.20	92.78	74.28	81.70	64.26	92.07	81.24	92.58	76.50	78.03	76.84
585	58.86	63.96	75.46	75.74	76.64	90.38	92.72	74.95	81.82	64.83	92.31	80.67	92.62	77.07	78.43	77.29
600	59.59	64.51	74.53	76.43	77 22	90.40	92.99	75.31	81.79	65.43	92.04	80.87	92.68	77.43	78.74	77.55
615	60.15	65.55	75.03	76.77	77 79			76.88	83.13	65.74		80.18	92.47	77.83	79.78	77.80
630	60.46	65.55	75.64	77.11	78.31	89.54	92.43	76.32	81.44	66.27	93.09	80.24	92.41	78.34	80.12	77.80
645	60.81	65.97	76.37	77.57	78.42	89.79	92.31	76.71	81.39	66.74	92.56	79.90	92.47	78.74	80.41	77.49
660	61.37	66.40	76.32	77.85	78.71	89.36	92.62	77.05	81.39	67.11	92.47	79.26	92.35	79.03	80.98	77.15
675	61.82	66.82	76.71	78.31	78.77	89.60	92.55	77.39	81.62	67.54	92.78	79.03	92.41	79.55	80.93	77.49
690	62.23	67.19	76.88	78.48	78.94	89.17	92.55	77.96	81.67	67.86	92.72	78.52	92.17	79.84	81.44	77.72
705	62.54	67.51	76.68	78.77	79.11	89.54	92.18	78.14	81.44	68.34	92.72	78.29	92.23	79.90	81.79	77.49
720	62.95	67.78	77.68	79.00	79.46	89.36	92.06	78.37	81.56	68 66	92.35	78.00	92.17	80.30	81.85	77.26
735	63.31	68.16	76.26	79.34	79.69	89.23	92 06	78.71	81.44	68.87	92 64	77.55	92.17	80.52	82.14	77.43
750	63.52	68.43	77.11	79.52	79.98	89.48	92.18	78.94	81.85	69.36	92 54	77.60	92.17	80.93	82.19	77.32
765	63.98	68.91	76.88	79.81	80.21	89.36	91.75	79.11	81.79	69.63	92.54	76.98	92.04	81.10	82.60	77.49
780	64.24	69.02	76.88	79.98	80.38	89 79	91.93	79.34	81.79	69.90	92.10	77.21	91.98	81.27	82.72	76.70
795	64.56	69.34	76.32	80.21	80.73	89.73	91.87	79.63	81.04	70.12	92.10	75.41	91 80	81.33	82.72	76.98
810	64.66	69.56	75.70	80.44	80 67	89.85	91.63	79.81	81.10	70.33	91 98	75.30	91.86	81.56	83.07	77.43
825	65.08	69.89	75.14	80.67	80.96	89.73	91.75	79.92	81 04	70.38	91 92	75.19	91.80	81.73	83.01	77.83
840	65.06	69.76	73.68	80.54	80.89	89.66	91 63	79.97	80.32	70 74	92.12	74.38	91 69	81.81	83 44	77.86
855	65.27	70.03	72.74	80.83	80 95	89.48	91.32	80.09	80.38	70 84	92 00	74.27	91 75	82.10	83.50	78.14
870	65.42	70.25	72.69	80.95	81.18	89.42	91.26	80.20	79.92	71.17	91 88	74.05	91.82	82.16	83 38	78.26
885	65.79	70.52	71.76	81 12	81.18	89.48	91.07	80.37	79.57	71.38	91 69	73.72	91.51	82.28	83.50	78.83
900	65.90	70.62	71.06	81.24	81.41	89.42	90.95	80.54	79.52	71.38	91 75	73.39	91.20	82.39	83 56	79.06

Half Heater Experiment No. 1

Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	26.76	26.66	26.76	26.07	25.97	25.82	25.97		26.70	27.24	26.89	27 43	27.04	26.60	26.35	26.89
15	26.36	26.61	26.76	26.07	26.02	25.33	25.33		26.99	27 24	26.70	27 29	26.94	26.65	26.26	26.79
30	26.17	26.66	26.76	26.07	25.97	26.07	25.53		26.79	27.09	27.63	27.43	26.75	26.60	26.55	26.79
45	26.17	26.56	31.63	25.82	25.97	40.54	53.69		40.28	27.29	93.96	61 84	64 43	26.65	26.92	26.84
60	26.07	26.46	44.25	26.17	26.07	35.03	66.89		56.28	27.19	93.32	74.29	86.20	26.65	32.89	32.43
75	26.07	26.66	48.76	26.46	27.85	32.81	71.90		58.59	27.14	93.07	71 49	90.78	27.58	33.14	38.35
90	26.45	27.39	52.01	27.78	30.45	34.48	68.89		60.13	27.55	93.00	68.52	92.81	29.04	33.87	43.40
105	26.79	28.38	53.08	29.14	32.78	34.22	66.95		58.25	27 85	93.06	71.77	94.13	30.99	36.93	45.82
120	27.39	29.39	53.57	30.85	34.79	35.94	70.80		58.86	28.74	92.75	71.99	94.77	33.68	38.09	46.05
135	28.18	30.80	54.06	32.83	36.31	36.52	60.98		57.95	29.99	92.81	71.82	95.15	35.62	38.78	46.10
150	29.09	31.81	56.20	34.53	37.69	37.21	62.99		60.33	31.09	92.38	70.69	95.37	37.09	39.97	45.82
165	30.00	32.68	57 45	35.94	38.86	36.73	64.98		61.70	32.09	92.01	70.09	95.53	38.20	40.98	46.21
180	30.90	33.60	56.30	37.16	40.33	36.83	64.24		61.55	33.10	91.45	69.88	95.53	39.75	41.89	46.66
195	31.78	34.53	55.25	38.60	41.35	37.43	61.49		59.57	33.92	91.39	68.58	95.43	40.98	43.08	48.70
210	32.65	35.39	54.92	39.88	42.35	37.50	62.18		61.06	34.87	89.20	71.79	95.01	42.18	44.03	48.16
225	33.52	36.28	54.77	40.79	43.61	37.72	63.32		63.16	35.70	88.28	70.11	94.63	43.21	44.74	49.25
240	34.40	37.19	54.77	41.81	44.66	38.47	61.97		60.20	36.59	87.98	65.19	84.36	44.14	45.91	50.68
255	35.23	37.99	54.03	42.90	45.44	39.22	64.79		59.23	37.17	87.31	61 98	93.87	45.24	47.03	49.97
270	36.07	38.58	53.25	43.78	46.34	39.66	67.08		59.03	37.91	86.64	61.11	93.77	46.30	47.65	49.73
285	36.71	39.55	52.47	44.76	47.25	40.36	66.54		58.22	38.76	86.22	59.18	93.27	47.14	48.61	49.82
300	37.40	40.41	51.69	45.61	48.00	41.00	65.47		57.11	39.45	85.56	57.41	93.09	48.04	49.58	49.87
315	37.93	41.00	50.83	46.46	48.76	41.38	66.70		55.77	40.15	85.14	55.47	92.78	48.78	50.06	49.68
330	38.67	41.63	49.85	47.17	49.37	41.69	70.48		54.91	40.77	84.53	53.73	92.26	49.56	50.94	49.90
345	39.21	42.17	48.94	47.93	49.80	42.23	69.50		54.66	41.52	83.88	52.28	91.95	50.14	51.28	49.71
360	39.84	42.66	47.91	48.60	50.28	43.16	69.83		54.66	41.95	83.56	51.13	91.46	50.85	51.85	49.95
375	40.29	43.05	47.34	49.22	50.76	43.93	71.08		54.76	42.65	83.05	50.33	91.09	51.23	52.48	49.90
390	40.72	43.80	46.49	49.85	51.58	43.98	71.66		54.52	43.19	82.18	49.61	90.41	51.90	53.05	49.95
405	41.20	44.20	45.93	50.43	51.96	44.87	71.73		54.52	43.52	81.94	49.09	89.86	52.43	53.59	49.80
420	41.83	44.59	45.54	51.05	52.50	45.37	71.57		54.57	44.29	81.60	48.31	89.18	53.01	54.08	49.90
435	42.17	45.04	45.20	51.34	53.08	46.21	71.46		54.71	44.73	81.08	47.85	88.51	53.44	54.57	49.66
450	42.50	45.61	45.03	52.12	53.58	46.77	71.62		54.50	45.00	80.57	47.23	87.67	53.91	54.89	49.69
465	43.10	46.15	44.75	52.55	53.97	47.00	71.29		54.45	45.38	80.22	46.84	87.06	54.21	55.19	49.74
480	43.54	46.80	44.59	53.09	54.41	48.13	70.91		54.70	45.94	79.88	46.39	86.48	54.60	55.44	49.59
495	43.70	47.17	44.31	53.43	54.91	48.60	70.80		54.70	46.44	79.18	46.22	85.88	55.04	56.08	49.83
510	44.20	47.51	44.20	53.87	55.35	48.90	70.37		54.94	46.67	78.89	46.00	85.44	55.34	56.13	49.93
525	44.53	47.73	43.92	54.21	55.65	49.67	70.04		54.99	47.00	78.60	45.72	84.90	55.68	56.53	50.12
540	44.97	48.23	43.92	54.71	55.95	50.20	69.71		54.94	47.29	78.14	45.44	84.54	55.98	56.73	50.21
555	45.25	48.56	43.70	55.00	56.25	50.86	69.55		54.94	47.68	77.80	44.94	83.77	56.48	57.13	50.26
570	45.60	49.11	43.77	55.27	56.62	51.32	69.18		55.21	48.09	77.41	44.73	83.13	56.75	57.60	50.42
585	45.88	49.30	43.61	55.72	56.92	52.04	69.23		55.21	48.32	77.07	44.51	82.60	57.05	57.85	50.76
600	46.33	49.68	43.55	55.87	57.12	52.52	68.85		55.31	48.60	76.61	44.40	81.90	57.40	58.15	50.80
615	46.44	49.93	43.50	56.22	57.38	53.06	68.63		55.36	48.99	76.10	44.07	81.32	57.60	58.51	51.33
630	46.67	50.12	43.06	56.47	57.58	53.06	68.47		55.46	49.23	75.77	43.86	80.92	57.85	58.76	51.76
645	46.89	50.36	42.73	56.72	57.83	53.45	68.25		55.46	49.47	75.26	43.69	80.40	58.05	58.81	52.06
660	47.06	50.65	42.46	56.92	57.93	53.40	67.93		55.36	49.76	74.98	43.53	79.82	58.15	59.27	51.66
675	47.46	50.93	42.51	57.17	58.29	53.84	67.66		55.26	50.00	74.65	43.36	79.30	58.56	59.48	51.57
690	47.43	51.08	42.20	57.44	58.30	54.44	67.52		55.08	50.25	74.22	43.16	78.69	58.73	59.70	52.18
705	47 60	51.27	42.04	57.54	58.61	54.98	67.25		54.98	50.54	74.05	43.33	78.23	58.99	60.01	52.06
720	47.94	51.42	41.82	57.69	58.68	55.43	67.08		54.73	50.63	73.61	42.95	77.71	58.93	59.91	52.35
735	48.11	51.66	41.71	57.84	58 81	55.98	66.98		54.54	50.82	73.28	42.89	77 09	59.24	59.96	51.97
750	48.40	52.00	41.55	58.25	58.98	57.23	66.82		54.15	51.01	72.84	42.73	76.52	59.50	60.21	52.02
765	48.49	52.09	41.66	58.30	59.02	58.20	66.55		55.67	51.25	72.57	42.51	76.07	59.55	60.26	51.97
780	48.73	52.43	41.66	58.40	59.17	59.07	66.39		56.77	51 39	72.35	42.35	75.45	59.75	60.31	52.06
795	48.83	52.48	41.55	58.66	59.43	59.58	66.28		56.97	51.68	72.07	42.24	75.00	59 85	60.46	52.06
810	49.05	52.57	41.44	58.65	59.52	59.88	66.28		57.52	51.78	71.80	42.08	74.33	59.96	60.56	51.82
825	49.20	52.71	41.44	58.80	59.68	60.04	66.07		57.57	51.82	71.53	41.87	74.00	60.01	60.71	51.82
840	49.20	53.00	41.39	58.86	59.83	60.34	65.91		57.67	52.21	71 31	41 81	73.50	60.11	60.78	51.58
855	49.44	53.15	41.33	58.86	59.88	60.75	65.91		57.92	52.35	71.10	41.71	72.90	60.21	60.87	51.97
870	49.44	53.15	41.39	58.96	59.94	60.75	65.75		57.82	52.45	70.66	41.49	72.57	60.26	61.02	51.82
885	49 68	53.35	41.39	59.11	60.04	60.96	65.54		57.77	52.54	70.29	41.28	72.07	60.41	60 97	51.63
900	49.82	53.49	41.06	59.21	60.09	61.11	65.33		57.92	52 64	70 13	41.22	71.69	60.36	60 92	52.11

Half Heater Experiment No. 2

Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	27.82	27.97	23.71	27.92	27.87	27.62	27.67		27.74	29.48	28.18	23.90	28.38	28.18	27.84	26.75
15	28.12	28.02	23.90	27.87	27.77	25.94	26.34		27.89	29.38	28.28	24.52	28.18	28.23	27.79	27.19
30	28.02	27.97	24.29	27.72	27.77	28.48	37.41		32.08	29.53	28.63	37.33	28.03	28.03	27.74	26.85
45	27.82	28.02	26.57	27.67	27.72	73.08	41.87		43.49	29.38	93.33	61.26	68.23	28.18	27.84	31.62
60	27.97	27.97	32.10	27.92	26.93	65.65	66.50		52.47	29.28	91.47	61.53	86.82	28.08	33.09	37.92
75	28.11	28.41	35.48	28.61	30.47	69.26	69.86		53.46	29.42	93.31	62.83	92.63	29.47	35.22	46.21
90	28.31	29.12	37.97	29.98	32.44	53.29	72.09		56.75	29.67	92.94	64.22	95.56	31.21	36.05	47.22
105	28.78	30.08	39.80	31.38	34.86	60.67	68.28		53.85	30.42	92.88	62.11	97.14	33.38	37.63	47.50
120	29.62	31.13	40.50	33.52	36.53	58.88	63.66		53.65	31.38	93.19	62.16	97.03	36.00	39.71	47.78
135	30.62	32.29	40.66	35.38	38.07	64.23	64.39		51.92	32.52	93.00	61.50	96.10	37.94	40.66	48.00
150	31.58	33.10	40.55	36.85	39.42	64.71	60.78		51.25	33.58	92.32	59.63	95.39	39.01	42.00	48.12
165	32.65	34.19	40.12	38.29	40.76	62.36	67.74		51.16	34.68	92.50	61.81	95.01	40.40	42.88	47.89
180	33.46	35.01	39.80	39.58	42.06	64.03	70.13		52.54	35.64	92.38	65.27	94.85	41.78	43.95	47.95
195	34.34	35.91	39.59	40.98	43.26	52.13	60.99		53.27	36.37	92.03	69.55	94.70	43.03	45.27	47.96
210	35.18	36.75	40.18	42.12	44.09	47.16	64.77		57.96	37.42	90.80	73.57	94.85	44.39	46.44	48.87
225	35.96	37.65	42.01	43.37	45.20	48.54	65.88		60.60	38.37	90.37	71.11	95.03	45.33	46.94	49.59
240	36.91	38.56	43.81	44.36	46.15	45.75	65.03		61.71	39.12	88.98	67.07	94.54	46.22	48.36	50.64
255	37.71	39.43	46.15	45.36	46.88	45.36	76.52		62.58	39.93	88.29	63.30	94.06	47.23	49.45	51.49
270	38.46	40.13	46.77	46.43	48.07	45.42	71.07		61.91	40.78	87.92	60.70	93.52	48.24	50.49	52.40
285	39.32	40.88	46.82	47.28	49.01	45.08	71.34		62.94	41.58	87.68	59.18	93.21	49.11	51.54	53.32
300	40.18	41.52	46.32	48.19	49.83	45.75	71.23		60.24	42.43	87.62	58.11	93.15	49.88	52.26	54.29
315	40.87	42.54	46.02	49.11	50.69	45.91	74.14		59.38	43.46	87.03	57.07	92.79	51.13	53.33	55.04
330	41.62	43.14	45.41	50.02	51.45	46.53	77.36		59.33	44.11	87.09	55.13	92.79	51.89	53.57	54.74
345	42.11	43.89	44.85	50.88	52.08	47.15	78.16		58.72	44.82	89.35	53.43	92.54	52.75	54.20	54.64
360	42.81	44.35	44.35	51.60	52.61	48.17	77.99		58.37	45.48	90.21	52.03	93.41	53.43	54.45	53.91
375	43.42	44.85	44.13	52.18	53.20	49.16	77.76		58.12	45.87	90.39	51.17	93.91	54.06	55.33	53.48
390	43.97	45.52	43.85	52.90	53.83	50.69	77.36		58.07	46.43	90.45	50.42	93.91	54.69	55.68	53.23
405	44.52	45.97	43.69	53.49	54.42	51.89	76.68		57.97	46.99	90.57	50.09	93.72	55.23	56.62	53.14
420	45.07	46.08	43.64	54.13	55.21	53.39	76.56		58.17	47.49	90.51	49.66	93.41	55.68	57.36	53.62
435	45.62	46.51	43.40	54.60	55.64	54.60	76.38		58.14	47.99	90.10	49.19	92.87	56.14	57.54	53.44
450	46.12	47.08	43.18	55.19	56.29	55.69	75.87		58.34	48.27	89.43	48.95	92.31	56.79	58.09	53.83
465	46.51	47.53	43.02	55.89	56.94	56.59	75.25		58.45	48.84	88.94	48.90	91.88	57.39	58.75	54.17
480	46.97	48.04	42.96	56.24	57.45	57.19	74.69		58.55	49.24	88.14	48.84	91.08	57.84	58.80	54.37
495	47.42	48.56	43.02	56.84	58.00	57.80	74.24		58.70	49.62	87.47	48.78	90.41	58.34	59.56	54.47
510	47.87	49.04	42.80	57.40	58.36	58.18	73.69		58.80	50.15	86.83	48.95	89.61	58.75	59.97	54.71
525	48.42	49.42	42.96	57.75	58.77	58.36	73.13		58.85	50.57	85.84	48.78	88.75	59.26	60.43	54.71
540	48.94	49.90	42.80	58.31	59.18	58.56	72.74		59.05	51.00	85.01	48.78	87.78	59.56	60.68	55.01
555	49.34	50.45	42.87	58.73	59.71	58.83	72.42		59.17	51.39	84.07	48.74	86.99	60.04	61.20	54.87
570	49.68	50.78	42.93	59.04	59.91	59.14	71.93		59.22	51.78	83.18	48.52	86.15	60.34	61.55	54.97
585	50.02	51.07	42.65	59.35	60.32	59.24	71.71		59.48	52.11	82.42	48.46	85.37	60.69	61.75	55.12
600	50.40	51.45	42.65	59.96	60.57	59.55	71.38		59.42	52.54	81.67	48.63	84.54	60.84	62.11	55.27
615	50.68	51.74	42.65	60.01	60.88	59.71	71.16		59.63	52.83	80.92	48.29	83.60	61.04	62.32	55.61
630	51.11	52.03	42.60	60.42	60.98	59.96	70.95		59.63	53.02	80.23	48.06	82.83	61.45	62.57	55.76
645	51.26	52.27	42.60	60.62	61.34	60.17	70.68		59.73	53.36	79.42	47.95	82.13	61.75	62.98	55.56
660	51.69	52.56	42.49	60.88	61.49	60.22	70.40		59.68	53.60	78.90	48.06	81.32	61.91	62.98	55.66
675	51.81	52.73	42.36	61.06	61.57	60.55	70.33		59.71	53.83	78.19	47.92	80.61	62.04	63.27	55.59
690	52.10	52.93	42.30	61.31	61.67	60.50	70.17		59.76	54.12	77.62	47.70	79.86	62.45	63.48	55.44
705	52.30	53.17	42.30	61.42	61.98	60.60	69.95		59.66	54.41	77.23	47.64	79.34	62.35	63.48	55.64
720	52.63	53.41	42.25	61.52	62.29	60.80	69.84		59.30	54.61	76.49	47.47	78.65	62.60	63.84	55.74
735	52.73	53.66	42.09	61.88	62.29	60.91	69.79		59.15	54.75	76.21	47.25	78.02	62.70	63.74	55.84
750	53.02	53.81	41.98	61.72	62.29	61.21	69.52		58.94	54.90	75.53	47.08	77.62	62.81	63.99	55.64
765	53.17	54.05	41.82	61.93	62.39	61.52	69.40		58.44	55.15	75.25	47.06	76.89	62.96	63.94	56.23
780	53.38	54.20	41.87	62.08	62.50	61.72	69.18		58.18	55.19	75.03	46.86	76.49	63.06	64.10	55.79
795	53.43	54.22	41.57	62.22	62.58	61.70	69.22		57.86	55.37	74.73	46.66	76.02	63.15	63.97	56.51
810	53.43	54.27	41.57	62.27	62.73	61.91	68.89		58.72	55.62	74.18	46.44	75.57	63.25	63.92	56.02
825	53.73	54.46	41.52	62.22	62.73	62.06	68.84		59.79	55.72	73.84	46.16	75.18	63.35	64.18	55.97
840	53.73	54.61	41.41	62.53	62.63	62.01	68.62		60.50	55.87	73.57	46.10	74.84	63.30	64.29	56.06
855	53.82	54.71	41.36	62.47	62.89	61.96	68.62		60.80	55.92	73.46	45.82	74.34	63.35	64.18	55.72
870	54.07	54.76	41.36	62.58	62.89	62.16	68.46		61.36	56.16	72.91	45.60	74.12	63.41	64.55	55.82
885	54.17	54.91	41.14	62.63	63.04	62.16	68.40		61.51	56.21	72.96	45.49	73.84	63.56	64.23	55.97
900	54.22	55.06	41.03	62.63	62.89	62.27	68.13		61.51	56.26	72.58	45.44	73.40	63.46	64.13	55.77

Half Heater Expenment No. 3

Timer	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	27.41	26.91	27.16	26.32	26.52	26.27	26.37	26.42	26.95	27.54	27 05	27 59	27.05	27 19	26.90	
15	27.26	26.86	27.16	26.32	26.62	26.37	26.27	26.62	26.95	27.49	26.80	27.59	26.90	27 24	26.90	
30	27.01	26.96	27.11	26.27	26.27	26.08	26.23	26.37	26.90	27.49	26.95	27.74	27 00	27 24	26.95	
45	27.09	26.96	27.09	26.25	26.35	26.35	26.84	26.59	27.07	27.86	27.07	27.71	27 02	27.32	27.02	
60	27.04	26.79	27.19	26.40	26.25	27 38	29.58	26.59	27.07	27 51	81.59	27 91	28.75	27 12	27 02	
75	27.09	26.84	30.19	26.25	26.40	28.13	45.17	26.54	50.82	27 51	93.63	68.34	76.47	27 12	32.31	
90	26.94	26.89	35.85	26.40	26.89	34.29	54.13	26.59	53.46	27 56	93.19	73.62	88.69	27.22	34.35	
105	26.89	27.28	40.17	27.38	28.63	34.45	71.59	26.69	52.40	27 66	91.27	70.83	93.90	28.56	34 30	
120	27.28	27.88	42.37	28.18	30.74	33.93	72.83	27.48	51.82	28.01	90.35	68.72	99.29	29.56	34 20	
135	27.48	28.73	43.30	29.48	32.60	32.45	65.81	28.48	51.10	28.61	89.80	66.15	101 52	31.66	35.23	
150	28.28	29.68	43.41	31.24	34.29	33.01	58.18	29.84	49.87	29.46	89.12	63.58	101 41	33.74	36.59	
165	29.31	30.81	43.24	32.88	35.97	34.31	67.34	31.86	49.99	30.73	88.08	62.71	99.02	35.45	37.88	
180	30.26	31.86	42.86	34.26	37.23	34.05	65.12	33.39	49.42	31.83	87.11	60.47	96.15	36.76	39.30	
195	30.96	32.57	42.05	35.45	38.29	33.74	64.28	34.72	48.88	32.48	84.95	57.33	94.68	37.97	40.05	
210	31.81	33.44	41.19	36.55	39.31	34.57	65.12	35.87	47.53	33.40	83.71	57 23	92.94	38.98	40.98	
225	32.47	34.00	40.28	37.55	40.28	34.98	61.85	37.02	46.97	33.91	83.29	55.44	91 94	39.89	42.35	
240	33.08	34.88	39.85	38.51	41.24	35.34	61.85	37.92	46.02	34.68	82.13	53.68	91.08	40.85	43.05	
255	34.00	35.76	39.37	39.47	41.99	35.92	62.21	38.88	46.08	35.30	81.54	51.75	90.23	41.92	43.54	
270	34.57	36.23	39.04	40.23	42.70	36.28	60.98	39.74	46.13	36.02	80.62	50.18	89.67	42.73	44.69	
285	35.03	36.70	38.51	40.82	43.09	37.02	62.26	40.18	46.03	36.22	79.57	48.46	88.69	43.06	44.81	
300	35.66	37.29	38.19	41.57	43.63	38.62	65.39	41.03	46.15	36.80	78.82	47.78	88.20	43.77	45.31	
315	36.07	37.76	38.19	42.33	44.35	38.73	66.34	41.73	46.65	37.38	78.82	46.82	87.41	44.37	45.70	
330	36.70	38.24	38.03	42.92	44.98	38.24	65.02	42.49	46.93	37.91	77.90	46.09	86.50	44.76	46.54	
345	37.29	38.67	37.87	43.47	45.46	38.67	65.92	43.20	47.44	38.60	76.99	45.53	85.84	45.48	46.76	
360	37.82	39.26	37.87	43.98	45.90	40.23	65.07	43.80	47.72	39.03	76.47	46.26	85.06	46.20	47.33	
375	38.08	39.75	37.71	44.62	46.41	41.19	65.86	44.29	48.06	39.57	75.91	45.81	84.41	46.59	47 72	
390	38.76	40.29	37.71	45.23	46.86	41.09	66.82	44.85	48.23	40.00	75.35	45.81	83.82	47.21	48.57	
405	39.08	40.80	37.64	45.77	47.46	41.39	65.90	45.27	48.78	40.46	74.94	45.79	83.26	47.65	49.24	
420	39.51	41.07	37.69	46.17	47.86	42.42	65.16	45.77	49.10	40.89	74.49	47.59	82.50	48.16	49.48	
435	40.00	41.60	37.58	46.56	48.03	43.12	65.27	46.22	49.38	41.32	74.16	46.69	81.86	48.44	49.88	
450	40.32	41.87	37.64	47.01	48.64	43.78	65.69	46.78	49.62	41.69	73.55	45.85	81.28	48.84	50.15	
465	40.75	42.20	37.53	47.35	48.97	43.62	65.53	47.18	49.77	42.07	73.28	44.74	80.65	49.24	50.57	
480	40.98	42.58	37.42	47.74	49.31	44.55	65.32	47.46	49.77	42.34	72.73	44.30	79.96	49.57	50.81	
495	41.23	42.85	37.27	48.20	49.64	44.72	65.01	47.92	49.72	42.61	72.45	43.81	79.49	50.05	51.29	
510	41.71	43.12	37.21	48.54	49.98	45.05	64.69	48.03	49.77	42.99	72.29	43.15	78.91	50.29	51.72	
525	42.46	43.82	37.43	49.14	50.62	46.09	64.62	48.95	49.68	43.63	72.09	42.98	78.57	50.72	52.10	
540	42.63	44.15	37.17	49.52	50.81	46.99	64.41	49.18	49.63	43.85	71.76	42.71	78.06	51.00	52.29	
555	42.84	44.37	36.91	49.81	51.09	47.38	64.25	49.52	49.34	44.18	71.70	42.28	77.55	51.29	52.73	
570	43.01	44.65	36.70	50.14	51.43	47.67	64.20	49.86	49.10	44.40	71.38	41.79	77.09	51.58	52.92	
585	43.55	45.04	36.54	50.24	51.57	47 95	64.15	50.05	48.82	44.73	71 22	41.47	76.81	51.81	53.26	
600	43.72	45.26	36.43	50.57	51.81	48.18	64.25	50.43	49.63	44.84	70.84	41.15	76.36	52.05	53.65	
615	43.93	45.48	36.33	50.90	52.00	49.38	64.30	50.66	50.25	45.28	70.58	40.83	76.07	52.25	53.79	
630	44.21	45.70	36.22	51.19	52.24	50 05	64.62	50.90	50.67	45.45	70.35	40.62	75.51	52.53	53 94	
645	44.37	45.93	35.90	51.37	52.42	50.70	64.47	50.94	49.98	45.50	70.21	40.29	75.14	52.51	54.07	
660	44.48	46.09	35.85	51.56	52.67	51.65	64.20	51.32	49.74	45.78	69.77	39.81	74.81	52.75	54.11	
675	44.70	46.26	35.48	51.85	52.71	52.18	64.10	51.41	49.74	45.95	69.67	39.75	74.42	53.00	54.21	
690	44.78	46.54	35.43	51.85	52.96	52.91	63.94	51.65	49.74	46.06	69.39	39.81	74.03	53.24	54.60	
705	45.20	46.77	35.27	52.13	53.00	53.25	63.68	51.94	49.74	46.28	69.23	39.59	74.03	53.43	54.56	
720	45.31	46.88	35.48	52.47	53.44	53.54	63.63	52.23	49.74	46.51	69.07	39.65	73.81	53.53	55.00	
735	45.65	47.22	35.48	52.57	53.30	53.88	63.48	52.33	49.74	46.79	68.90	39.32	73.53	53.82	55.10	
750	45.76	47 33	35.22	52.76	53.39	54.17	63.42	52.52	49.89	46.95	68.74	39.27	73.20	53.87	55.20	
765	45.96	47 59	35.37	52.95	53.92	54.51	63.38	52.76	50.09	47.21	68.83	39.26	73.17	54.31	55.79	
780	46.13	47.68	35.37	53.14	53.87	54 76	63.30	53.00	50.18	47 55	68 72	39.00	72.90	54.36	55.94	
795	46.41	47 99	35.37	53.39	53.92	55.05	63.10	53.24	50.33	47.67	68.40	39.05	72.51	54.46	55 94	
810	46.52	48.10	35.21	53.44	54.22	55.10	63.20	53.39	50.33	47 78	68.34	39.00	72.19	54.66	56.19	
825	46.69	48.16	35.06	53.58	54.22	55.25	62.99	53.53	50.37	47 95	68.13	38.89	71.97	54.76	56.29	
840	46.80	48.39	34.85	53.73	54.36	55.50	62.84	53.63	50.37	48.06	67 56	38.94	71 70	54.95	56.34	
855	47 03	48 44	34.69	53.83	54.27	55.69	62.74	53.73	50.42	48.23	67.48	39.00	71 26	55.05	56.44	
870	47.08	48.67	34.54	53.92	54.46	55.74	62.58	53.97	50.47	48.35	67.54	38.94	71.05	55.15	56 44	
885	47.41	48.71	34 63	54.18	54.55	55.93	62.52	54 11	50.46	48.61	67 31	38.93	70.65	55.14	56 58	
900	47.48	49.02	34.53	54.21	54.80	55.98	62.37	54.21	50.56	48.84	67 21	39.15	70.38	55.19	56 53	

Half Heater Experiment No. 4, paper towel wick

Timer	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	28.25	27.95	24.10	28.50	28.40	29.10	26.43	29.20	28.27	29.62	28.91	25.33	29.46	29.41	29.21	
15	28.30	28.15	24.34	28.35	28.65	28.60	28.20	29.30	28.71	29.56	29.31	25.86	29.48	29.56	29.31	
30	28.45	28.05	24.44	28.40	28.75	28.15	28.25	29.20	28.88	29.56	29.51	26.10	29.31	29.48	29.31	
45	28.30	28.05	24.88	28.55	28.55	29.35	28.25	29.00	28.81	29.72	90.88	26.40	39.40	29.46	29.67	
60	28.45	28.05	25.06	28.50	28.75	30.01	40.49	29.10	32.82	29.38	95.61	53.95	82.37	29.62	34.56	
75	28.45	28.25	26.33	28.85	29.25	30.66	75.44	29.05	57.21	29.51	95.34	55.13	90.25	29.56	36.85	
90	28.50	28.85	29.66	29.66	31.41	30.46	77.02	29.25	56.86	29.62	94.90	59.24	92.22	31.96	37.11	
105	28.95	29.30	33.43	30.90	34.05	31.21	77.59	30.51	52.74	30.36	94.96	59.90	92.97	33.33	37 75	
120	29.90	30.94	36.05	32.86	36.83	31.89	70.85	32.05	52.91	31.40	94 82	60.42	93.65	36.09	40.17	
135	30.74	31.84	37.04	34.70	38.47	32.25	65.84	33.67	51.14	32.25	94.39	56.78	93.58	38.35	41.86	
150	31.64	32.98	37.41	36.31	39.87	32.70	64.85	35.37	49.86	33.36	94 55	54.22	93.77	39.69	42.25	
165	32.45	33.98	37.36	37.83	41.20	33.31	66.17	36.99	49.18	34.49	93.77	52.19	93.96	41.07	43.38	
180	33.41	34.95	37.46	39.17	42.49	33.77	72.75	38.37	52.05	35.31	93.21	50.48	93.90	42.25	44.47	
195	34.28	35.84	37.46	40.24	43.30	34.59	73.52	39.54	52.53	36.19	90.99	49.12	93.96	43.33	45.41	
210	35.01	36.62	37.57	41.46	44.12	35.68	70.84	40.72	50.71	37.03	90.68	47.93	94.12	44.36	46.47	
225	35.69	37.41	37.36	42.70	45.33	36.52	69.33	41.68	50.24	37.93	90.01	47.03	94.17	45.24	47.25	
240	36.18	37.82	36.97	43.19	45.79	37.23	69.68	42.16	50.07	38.39	89.35	45.97	93.84	45.86	47.88	
255	37.08	38.40	36.86	44.18	46.40	37.98	69.62	43.14	49.73	39.19	88.66	45.03	93.89	46.81	48.92	
270	37.71	39.18	36.65	44.95	47.02	38.62	69.46	44.07	49.54	39.84	88.31	44.31	94.00	47.43	49.59	
285	38.19	39.64	36.60	45.67	47.70	39.42	69.79	44.73	49.59	40.42	87.76	43.87	93.84	48.28	50.21	
300	38.94	40.23	36.34	46.46	48.55	40.23	69.35	45.56	49.68	40.96	87.57	43.38	93.84	48.85	50.78	
315	39.48	40.76	36.29	47.02	49.29	40.92	69.08	46.23	50.02	41.81	87.15	43.11	93.78	49.35	51.35	
330	40.07	41.30	36.13	47.70	49.77	41.73	68.97	46.74	50.07	42.19	86.67	42.79	93.55	49.97	52.06	
345	40.55	41.89	36.08	48.21	50.48	42.32	68.86	47.41	50.49	42.95	86.18	42.41	93.30	50.54	52.11	
360	41.21	42.55	36.15	49.03	51.03	43.21	68.87	47.99	51.00	43.67	85.81	42.42	93.58	51.29	52.82	
375	41.58	43.04	36.51	49.51	51.60	44.03	68.77	48.67	51.15	44 05	85.27	42.05	93.21	51.82	53.40	
390	42.07	43.53	36.78	50.08	52.13	44.80	68.77	49.17	51.43	44.49	84.97	41.83	92.96	52.29	54.04	
405	42.61	43.92	36.83	50.55	52.52	45.46	68.55	49.75	51.53	44.88	84.26	41.62	92.58	52.68	54.72	
420	42.93	44.25	37.09	51.03	52.90	46.13	68.49	50.27	51.86	45.43	83.84	41.72	92.28	53.21	55.26	
435	43.21	44.80	37.25	51.41	53.34	46.75	68.22	50.65	51.67	45.82	83.20	41.88	91.84	53.55	55.48	
450	43.59	45.02	37.41	51.80	53.63	47.42	68.01	51.08	51.77	46.43	82.32	41.83	91.41	53.94	55.71	
465	44.14	45.52	37.41	52.18	54.12	47.82	67.96	51.41	51 72	46.65	81.86	41.99	90.92	54.23	55.95	
480	44.37	45.65	37.48	52.53	54.23	48.46	67.59	51.91	51.44	46.90	81.07	41.69	90.27	54.48	56.45	
495	44.65	46.20	37.48	53.02	54.68	49.09	67.38	52.10	51.20	47.12	80.32	41.58	89.60	54.77	56.70	
510	44.98	46.54	37.59	53.41	54.92	49.62	67.16	52.48	51.10	47.46	79.57	41.58	88.86	55.17	56.70	
525	45.15	46.71	37.75	53.85	55.22	50.10	66.95	52.92	52.20	47.91	78.82	41.52	88.19	55.46	56.90	
540	45.54	47.05	37.91	54.04	55.47	50.57	66.90	53.26	52.92	48.19	78.41	41.47	87.52	55.66	57.15	
555	45.87	47.38	37.75	54.23	55.86	50.90	66.58	53.50	53.80	48.42	77.61	41.52	86.49	55.91	57.30	
570	46.15	47.78	37.70	54.38	56.16	51.24	66.47	53.75	54.24	48.65	76.99	41.42	85.77	56.11	57.68	
585	46.37	47.95	37.70	54.82	56.11	51.67	66.26	54.04	54.43	48.88	76.20	41.26	84.81	56.50	57.78	
600	46.90	48.42	37.95	55.26	56.55	52.29	66.44	54.57	54.71	49.38	75.87	41.50	84.22	56.68	58.24	
615	47.12	48.39	38.05	55.46	56.85	52.53	66.33	54.77	55.10	49.52	75.14	41.50	83.22	56.93	58.34	
630	47.46	48.93	38.10	55.61	56.90	53.06	66.28	55.11	55.30	49.81	74.53	41.34	82.35	57.08	58.44	
645	47.57	49.19	38.10	55.80	57.20	53.40	66.17	55.16	55 49	50.00	73.92	41.55	81.48	57.28	58.49	
660	47.80	49.24	38.16	56.05	57.30	53.69	65.91	55.36	55.45	50.28	73.59	41.44	80.61	57.58	58.69	51.33
675	48.02	49.53	38.05	56.30	57.35	54.08	65.75	55.56	55.59	50.43	73.04	41.34	79.92	57.63	58.80	51.33
690	48.31	49.77	38.21	56.40	57.45	54.57	65.70	55.80	55.79	50.52	72.38	41.28	78.94	57.79	58.90	50.90
705	48.25	48.81	38.16	56.50	57.70	54.57	65.70	56.05	55.84	50.76	71.89	41.50	78.20	57.84	58.90	51.18
720	48.40	49.92	37.97	56.42	57.67	54.64	65.47	55.97	55.87	50.93	71.55	41.53	77.49	57.86	58.93	50.97
735	48.69	50.06	38.02	56.57	57.77	55.13	65.31	56.12	56.12	50.97	71.17	41.31	76.70	58.07	59.08	51.21
750	48.86	50.30	38.07	56.77	57.92	55.18	65.31	56.17	56.12	51.12	70.52	41.48	75.96	58.07	59.08	50.97
765	48.96	50.25	37.92	56.82	57.77	55.33	65.26	56.52	56.17	51.31	70.04	41.53	75.24	58.27	59.28	51.12
780	49.01	50.49	37.81	56.97	57.97	55.53	64.99	56.37	56.31	51.26	69.77	41.31	74.68	58.37	59.23	50.97
795	49.15	50.53	38.02	57.07	58.13	55.92	64.94	56.67	56.31	51.40	69.33	41.21	74.01	58.42	59.33	51.07
810	49.30	50.82	38.07	57.17	58.23	56.02	64.94	56.77	56.41	51.64	69.06	41.26	73.41	58.37	59.59	50.93
825	49.39	50.87	38.02	57.27	58.23	56.22	64.84	56.82	56 51	51.69	68.68	41.10	72.86	58.52	59.49	51.16
840	49.65	50.98	37.93	57.39	58.24	56.54	64.80	57.14	56.63	51 95	68 43	41.12	72 37	58.64	59.66	51.18
855	49 75	51.22	37.88	57.34	58.29	56.54	64.59	57.19	56.58	51.90	68.00	41.01	71 88	58.74	59.71	51.14
870	49.80	51.32	38.04	57 54	58.55	56.84	64 69	57 29	56 63	52.19	67.73	40.96	71 40	58.89	59 76	50.99
885	49.85	51.37	37 99	57.64	58.55	56.89	64.48	57 24	56 53	52.23	67 73	40.80	71 02	58.69	59 91	51.28
900	48.99	51.41	37.77	57.79	58.55	56.99	64.17	57.34	56 58	52.33	67 20	40.59	70 37	58.89	59 96	51.80

Full Modified Heater No. 1

Timer	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	25.72	25.48	25.72	25.48	25.33	25.52	25.28	25.67	26.33	26.58	26.23	26.62	26.13	26.43	26.23	26.53
15	25.77	25.57	25.92	25.38	25.48	27.36	36.97	25.67	26.62	26.58	26.48	26.62	26.28	26.38	26.18	26.48
30	25.72	25.67	26.02	25.38	25.52	34.07	87.14	25.67	32.14	26.62	41.32	26.97	36.87	26.33	26.23	26.77
45	25.77	25.38	45.93	25.38	29.88	88.31	92.58	25.67	50.21	26.53	94.05	44.77	78.78	26.38	26.67	36.90
60	25.67	25.67	57.10	26.61	36.97	74.93	90.24	26.02	54.57	26.62	93.46	62.64	87.67	28.57	33.32	46.29
75	25.57	26.56	55.54	28.18	35.85	65.82	-2.45	27.51	76.14	27.02	97.51	79.48	90.44	29.93	34.87	54.82
90	25.94	27.73	60.47	30.25	38.30	57.03	87.12	28.33	72.04	27.65	91.45	85.80	91.94	32.94	39.14	58.83
105	26.43	29.04	64.78	32.59	38.08	54.57	85.84	30.10	76.85	28.60	90.71	88.54	92.44	36.05	42.32	61.69
120	27.13	30.61	67.73	34.93	39.85	53.38	85.96	33.11	77.08	29.96	90.83	89.04	92.57	38.71	44.63	64.13
135	28.58	32.03	70.14	37.47	41.63	52.45	85.47	35.61	79.62	31.62	90.40	88.11	92.63	40.59	46.25	65.55
150	29.54	33.88	72.05	39.63	43.66	54.47	85.41	37.58	79.91	33.09	90.28	87.50	92.44	42.70	47.83	67.79
165	30.56	35.40	72.61	41.80	45.73	56.42	86.02	39.74	78.86	34.59	89.72	86.10	92.44	44.85	49.96	68.50
180	31.72	36.72	71.89	43.44	47.68	57.39	85.90	41.96	79.73	36.00	89.78	85.74	92.32	46.81	51.73	68.50
195	32.90	37.74	73.39	45.28	49.41	59.90	85.60	44.16	81.18	37.37	89.47	87.68	92.19	48.28	52.79	69.31
210	34.22	39.11	74.67	47.16	51.08	62.80	86.00	46.25	81.25	38.73	89.10	86.95	92.13	50.12	54.28	69.38
225	35.43	40.30	75.81	48.58	52.53	64.37	86.12	47.86	81.13	39.81	88.73	86.95	92.13	51.75	55.81	70.25
240	36.32	41.71	75.52	50.22	54.35	66.50	86.00	49.30	81.60	40.88	88.85	86.83	92.00	53.25	56.82	69.93
255	37.39	42.85	75.47	51.51	55.39	68.45	86.12	50.94	81.48	41.90	88.91	86.83	91.94	54.43	58.03	70.47
270	38.24	43.95	74.56	52.88	56.15	71.01	86.31	52.29	79.22	42.94	88.42	84.60	91.57	55.67	59.20	68.56
285	39.27	45.01	72.89	54.25	57.26	72.89	86.43	53.71	77.89	43.98	86.48	82.71	91.44	56.87	60.23	65.77
300	40.20	46.08	71.12	55.44	58.28	75.13	86.79	54.95	77.37	44.97	86.67	81.36	91.57	58.03	61.04	65.30
315	41.11	47.16	69.65	56.45	59.20	77.69	86.79	56.00	76.80	45.98	86.54	80.84	91.26	58.95	61.98	65.45
330	42.04	47.97	68.83	57.62	60.29	79.31	87.33	57.32	76.01	46.83	86.43	80.21	90.96	60.08	63.05	65.46
345	42.81	48.83	68.01	58.74	60.95	80.94	86.96	58.23	76.46	47.57	88.73	80.09	91.02	60.89	64.09	65.88
360	43.69	49.85	68.26	59.46	61.72	82.35	87.21	59.31	76.52	48.39	88.67	79.74	90.83	61.91	65.14	66.15
375	44.35	50.57	67.74	60.39	62.70	83.35	86.90	60.08	76.63	49.35	88.55	80.09	90.71	62.74	65.99	66.68
390	45.02	51.67	67.20	61.31	63.17	72.16	96.84	61.05	77.78	49.93	90.52	80.03	90.59	63.62	66.68	67.70
405	45.80	52.30	66.77	62.29	64.22	84.06	87.82	61.98	78.18	50.98	89.41	80.26	90.59	64.61	67.59	68.29
420	46.54	53.97	67.58	63.22	65.33	-68.36	181.55	63.54	81.31	51.84	120.30	81.42	90.46	65.40	68.35	68.95
435	47.28	54.02	68.01	64.06	65.81	80.24	91.72	63.90	78.70	52.52	91.39	81.19	90.34	66.20	68.95	69.27
450	48.27	54.72	67.91	64.86	66.72	83.89	89.55	64.81	79.40	53.22	89.97	81.60	90.28	67.17	69.99	69.99
465	48.99	56.57	68.67	66.14	67.86	-54.65	148.46	67.26	82.71	54.05	138.43	81.14	90.16	67.82	70.53	70.37
480	49.57	57.48	68.45	66.78	68.56	-45.62	157.02	69.00	82.77	55.03	122.84	82.66	89.91	68.52	71.07	71.24
495	50.25	57.13	69.11	66.89	68.51	78.67	89.86	66.46	80.85	55.08	95.18	82.24	90.03	69.28	71.82	71.84
510	50.87	58.50	69.55	67.80	69.82	74.79	90.91	67.96	82.48	55.88	106.23	83.07	89.91	70.05	72.22	72.77
525	51.40	58.19	69.00	68.29	70.15	86.54	88.56	68.56	81.14	56.38	90.40	83.90	89.60	70.48	73.21	72.99
540	51.83	58.81	68.73	68.89	70.69	88.68	87.51	69.22	80.04	56.93	89.48	84.13	89.66	71.07	73.71	73.32
555	52.27	59.37	68.40	69.44	71.29	88.19	89.49	69.77	79.51	57.43	88.55	84.07	89.54	71.67	74.21	73.80
570	52.66	59.90	68.69	69.84	71.65	89.41	89.72	70.23	80.14	57.89	87.20	84.24	89.10	72.03	74.42	73.75
585	53.35	60.36	69.51	70.61	72.14	92.26	88.04	70.61	80.72	58.50	86.77	82.94	88.86	72.42	74.81	74.19
600	53.69	60.92	68.58	71.15	72.69	91.33	89.41	71.15	80.31	59.02	87.20	85.98	89.17	72.86	75.37	74.38
615	54.09	61.49	68.31	71.70	73.19	89.65	89.97	71.59	80.37	59.43	87.75	85.98	89.10	73.30	75.65	74.58
630	54.58	61.90	68.37	72.20	73.64	89.16	90.21	72.31	80.72	59.89	88.24	85.86	88.98	73.58	76.33	75.15
645	54.98	62.37	68.26	72.53	73.92	88.17	91.45	72.69	80.89	60.30	88.24	85.92	88.86	74.25	76.87	75.94
660	55.43	62.89	67.28	72.86	74.14	88.60	91.08	73.08	80.89	60.65	88.18	85.74	88.49	74.53	76.98	76.33
675	55.73	63.20	67.12	73.14	74.59	89.97	90.03	73.58	81.24	61.06	87.93	85.62	88.24	74.92	77.36	76.33
690	56.48	63.77	66.30	73.67	75.13	89.05	89.61	74.01	81.09	61.78	88.14	85.05	87.83	75.35	77.79	76.71
705	56.94	64.08	66.36	74.06	75.41	88.74	90.48	74.29	80.98	62.24	87.93	84.27	87.53	75.74	78.02	76.78
720	57.34	64.55	66.30	74.46	75.58	89.55	89.99	74.57	81.33	62.50	87.40	83.79	87.22	75.86	78.25	77.28
735	57.80	64.87	65.68	74.74	76.15	90.35	89.43	75.02	81.56	62.81	87.16	82.97	87.04	76.31	78.68	78.82
750	58.05	65.24	66.73	75.07	76.38	89.05	89.74	75.19	81.39	63.22	86.98	82.38	86.55	76.59	78.77	78.78
765	58.51	65.40	66.89	75.24	76.38	90.42	89.36	75.58	80.86	63.53	86.92	81.50	86.43	76.88	79.24	78.94
780	58.77	65.72	65.82	75.53	76.89	90.11	89.49	75.58	80.52	63.79	86.49	81.09	86.07	76.88	79.30	78.88
795	59.02	65.98	65.03	75.81	77.01	89.61	89.05	75.92	80.34	64.21	86.49	80.11	85.83	77.16	79.30	77.34
810	59.22	66.39	64.11	76.06	77.20	89.63	89.75	76.23	79.75	64.35	86.43	79.23	85.58	77.21	79.17	76.81
825	59.73	66.60	64.32	76.29	77.55	89.94	89.19	76.40	79.46	64.61	86.16	78.13	85.22	77.27	79.17	76.87
840	60.04	66.77	63.17	76.40	77.43	89.38	89.19	76.63	78.59	64.72	86.18	77.50	84.92	77.27	79.46	76.18
855	59.99	66.98	62.24	76.52	77.78	88.32	88.95	76.75	78.24	65.08	85.98	76.64	84.74	77.67	79.81	76.47
870	60.19	67.19	61.37	76.63	77.83	89.25	88.51	76.97	77.61	65.40	85.70	75.50	84.50	77.84	79.93	76.47
885	60.45	67.36	61.11	76.75	77.78	88.88	88.70	76.92	77.38	65.51	85.40	74.55	84.20	77.90	79.75	75.79
900	60.50	67.68	60.35	76.92	77.89	88.95	88.27	77.03	76.87	65.56	85.16	73.99	83.85	77.84	79.75	75.56

Full Modified Heater Experiment No 2

Timer	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	26.16	26.55	26.11	26.36	26.55	26.31	26.41	26.75	27.64	27.44	27.29	27.24	27.64	27.64	27.29	27.39
15	26.21	26.50	26.41	26.55	26.36	49.43	42.16	26.70	27.39	27.64	38.32	27.74	27.89	27.69	27.39	27.54
30	26.16	27.30	42.76	27.15	27.35			29.10	54.79	27.79		49.86	71.52	29.44	29.29	33.03
45	26.26	26.95	45.76	27.70	31.46	96.65	85.10	27.60	52.93	27.59	95.80	59.79	85.70	31.20	33.39	45.21
60	26.50	27.90	45.14	30.37	32.45	94.28	85.94	28.70	56.08	28.19	94.71	61.01	88.81	31.96	37.14	48.11
75	26.75	26.85	45.93	33.47	33.89	93.31	84.32	30.12	55.48	28.49	94.33	62.34	89.62	34.16	38.80	47.98
90	27.10	31.78	47.80	36.24	36.14			34.51	58.76	29.85		65.00	89.18	36.35	40.36	50.57
105	27.88	32.12	50.85	37.69	37.80			34.01	56.29	30.52		66.37	88.34	38.11	43.34	54.21
120	28.43	33.04	53.22	39.41	40.17	91.67	85.77	36.63	60.45	31.67	91.67	67.65	88.59	40.47	46.33	56.99
135	29.04	34.43	56.24	40.60	42.27	91.24	86.50	39.14	62.60	32.89	91.06	68.79	88.47	42.57	47.97	58.20
150	29.80	35.94	59.28	42.33	44.47	90.80	85.95	41.73	64.78	34.28	90.75	70.37	88.47	44.38	49.62	58.35
165	30.55	37.32	61.12	44.53	47.62	91.18	88.89	43.97	65.94	35.73	87.98	70.53	88.28	46.16	51.63	59.32
180	31.51	38.60	62.67	46.43	49.79	90.44	88.20	45.98	66.90	36.94	88.90	70.42	88.34	48.31	53.03	60.24
195	32.42	40.01	63.76	48.50	51.95	89.82	88.21	47.85	67.28	38.32	88.22	69.99	88.53	50.01	54.35	60.24
210	33.19	41.51	64.34	50.46	53.51	89.63	87.66	49.60	67.65	39.40	88.34	69.50	88.65	52.31	55.29	59.07
225	34.25	42.91	64.89	52.08	55.02	89.36	87.51	50.97	68.17	40.72	87.87	68.28	88.60	53.95	56.77	59.62
240	35.24	44.17	64.63	53.54	56.36	89.11	87.64	52.66	67.68	41.90	87.14	68.55	88.86	55.63	58.19	59.87
255	36.13	45.28	64.47	54.97	58.03	89.05	88.36	54.18	68.01	42.93	86.84	68.28	88.73	56.92	59.26	60.84
270	37.08	46.41	64.63	56.18	58.39	88.99	87.64	55.61	68.17	44.03	86.11	67.52	88.67	57.98	60.53	61.35
285	37.94	47.54	64.42	57.22	59.36	88.56	87.82	57.02	68.49	45.08	87.57	67.68	88.73	59.05	61.86	62.01
300	38.80	48.52	65.16	58.29	60.59	88.43	86.11	58.23	69.04	46.03	88.43	67.31	88.55	60.33	62.47	62.78
315	39.61	49.48	65.69	59.36	61.46	88.99	87.45	59.41	69.91	46.96	88.30	67.25	88.61	61.29	63.72	63.25
330	40.26	50.39	65.95	60.54	62.64	88.93	87.94	60.34	70.34	48.00	87.75	67.47	88.61	62.16	64.92	63.98
345	40.92	51.03	67.06	61.54	63.40	88.80	87.32	61.33	70.87	48.96	88.18	67.77	88.54	63.49	65.69	64.22
360	41.63	51.85	67.92	62.36	64.34	89.11	86.78	62.31	71.90	49.97	87.99	68.26	88.79	64.27	66.81	65.08
375	42.44	52.68	68.52	63.19	65.24	89.11	86.00	63.30	72.56	50.87	88.42	68.20	88.48	65.16	67.56	65.53
390	43.26	53.41	68.63	64.13	66.25	89.36	86.65	64.03	73.22	51.64	89.78	68.53	88.61	65.95	68.75	66.27
405	43.98	54.15	68.68	65.03	66.95	89.17	87.20	64.98	73.44	52.36	88.61	68.69	88.42	66.91	69.29	66.75
420	44.87	54.74	68.73	65.77	67.60	89.17	86.11	65.93	73.89	53.43	88.98	68.80	88.36	67.88	70.00	67.56
435	45.76	57.09	69.72	66.90	69.39			68.57	76.07	54.66		69.45	88.48	68.58	71.03	67.99
450	46.66	56.19	69.17	67.43	68.79	88.24	89.05	67.38	74.61	55.30	89.47	70.05	88.48	69.23	71.19	68.10
465	48.44	56.78	70.39	68.21	69.90	89.28	88.72	68.43	75.13	56.33	88.18	70.34	88.49	70.02	72.08	69.04
480	48.97	59.32	70.99	69.57	72.41			71.81	78.08	57.43		71.21	88.55	70.83	72.80	69.09
495	49.79	58.96	71.15	69.63	70.99			69.90	77.05	57.84		70.56	88.61	71.21	73.29	70.18
510	50.22	58.65	71.59	70.17	71.64	88.05	88.72	70.55	76.15	58.39	90.09	70.45	88.73	71.97	73.90	70.72
525	50.94	59.11	72.08	70.72	72.08	89.90	88.23	71.04	76.54	59.06	89.60	71.05	88.98	72.41	74.52	71.10
540	51.75	59.47	70.28	71.48	72.74	90.09	88.60	71.48	76.54	59.57	89.85	71.86	89.10	73.13	74.85	71.65
555	52.77	60.09	70.82	72.08	73.46	89.84	88.85	71.92	77.05	60.54	89.91	72.36	89.35	73.74	75.84	71.97
570	53.45	60.50	72.14	72.47	73.96	89.96	89.03	72.52	77.85	61.04	90.34	72.47	89.29	74.40	75.92	71.59
585	53.91	60.82	72.23	72.83	74.11	89.59	88.66	72.94	77.54	61.58	90.50	71.68	89.39	74.66	76.56	72.44
600	54.45	61.33	71.62	73.28	74.84	89.40	89.71	73.50	77.56	62.04	90.38	72.39	89.39	75.16	77.20	72.66
615	55.04	61.69	71.40	73.72	75.52	89.65	89.15	74.06	77.89	62.75	90.75	72.44	89.51	75.61	77.54	72.83
630	55.49	62.21	69.61	74.28	75.57	89.78	89.03	74.50	77.66	63.07	90.75	72.83	89.39	75.84	77.89	72.77
645	55.98	62.52	71.62	74.73	75.74	89.84	88.66	74.73	78.18	63.54	90.44	72.11	89.33	76.41	78.35	72.99
660	56.39	62.93	71.73	75.01	76.42	90.15	88.84	75.29	78.35	63.90	90.62	71.84	89.33	76.92	78.68	73.55
675	56.79	63.25	72.12	75.35	76.71	90.27	89.71	75.63	78.64	64.43	90.44	72.28	89.14	77.20	79.04	73.60
690	57.10	63.61	71.19	75.86	76.94	90.45	89.46	75.97	78.58	64.79	90.07	72.66	89.27	77.49	79.10	73.68
705	57.62	63.99	71.74	76.15	77.46	90.64	89.22	76.55	78.64	65.17	89.55	72.51	89.27	77.72	79.40	74.11
720	58.08	64.25	72.02	76.60	77.69	90.76	89.18	76.77	79.05	65.44	89.64	73.06	89.21	78.01	80.03	74.11
735	58.23	64.62	70.76	76.77	77.86	91.26	88.54	77.17	78.53	65.86	89.83	72.23	89.21	78.41	80.15	73.67
750	58.74	64.83	69.62	77.06	78.04	91.20	88.11	77.17	78.12	66.07	90.50	71.91	89.14	78.64	80.50	74.78
765	59.00	64.99	69.89	77.23	78.32	90.89	89.22	77.58	78.53	66.39	89.45	71.58	88.90	78.82	80.55	75.34
780	59.20	65.25	68.69	77.52	78.50	90.95	89.09	77.69	77.76	66.71	89.76	71.31	88.96	79.16	80.55	75.68
795	59.46	65.41	68.74	77.69	78.67	90.52	88.54	77.98	78.07	66.98	90.01	72.07	88.77	79.22	80.73	75.68
810	59.66	65.73	68.85	77.92	78.90	90.27	88.97	77.98	78.82	67.35	89.89	72.56	89.08	79.45	81.19	75.51
825	60.10	65.97	67.37	78.07	79.05	90.12	88.51	78.24	77.69	67.28	90.27	72.33	88.91	79.51	81.25	75.45
840	60.31	66.13	63.71	78.42	79.11	89.88	89.01	78.53	77.49	67.49	89.66	72.38	88.98	79.39	81.42	76.18
855	60.36	66.24	64.18	78.53	79.23	89.19	88.82	78.71	77.55	67.71	90.03	72.11	88.85	79.74	81.42	76.01
870	60.92	66.24	68.07	78.59	79.64	89.50	89.32	78.82	77.49	67.98	89.66	70.21	88.79	79.98	81.60	75.50
885	60.81	66.45	69.32	78.76	79.58	89.44	88.39	78.88	78.12	68.25	89.41	70.15	88.67	80.09	81.54	76.07
900	61.27	66.88	71.12	79.11	79.64	87.96	87.84	79.05	78.58	68.25	89.91	70.15	88.51	80.27	81.90	75.16

Cold Tub Expenment No. 1

Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	3.75	2.78	2.66	4.53	4.04	3.75	4.78	4.69	5.30	6.12	5.59	6.48	5.71	5.67	5.71	5.63
15	3.75	3.02	2.78	4.53	4.08	3.75	4.89	4.49	5.38	6.04	5.55	6.33	6.04	5.63	5.75	3.23
30	3.25	2.47	2.03	3.74	3.29	2.98	3.94	3.78	4.87	5.57	5.20	5.99	5.45	5.08	5.20	2.32
45	3.04	2.43	1.95	3.70	3.41	3.00	4.11	3.94	4.87	5.66	5.04	5.86	5.57	5.24	5.20	2.36
60	3.00	2.43	2.03	3.70	3.37	3.00	4.11	3.90	4.83	5.66	5.20	5.90	5.53	5.28	5.28	2.36
75	3.04	2.47	2.15	3.90	3.37	3.04	4.23	3.99	5.08	6.20	5.16	5.86	5.53	5.28	5.45	2.86
90	3.04	2.47	2.11	3.78	3.45	3.12	8.86	3.99	4.87	9.66	5.28	5.99	5.57	5.45	5.45	3.04
105	6.57	2.51	2.07	4.73	3.41	3.17	19.57	4.11	5.04	15.40	5.66	6.24	6.32	5.80	5.74	3.04
120	13.30	2.96	2.15	16.39	4.03	3.00	27.16	4.89	5.12	20.77	6.99	6.86	7.28	6.65	6.11	3.32
135	18.03	4.11	2.27	25.55	7.12	3.33	31.68	6.57	5.57	25.41	8.72	8.13	8.47	7.79	6.95	3.40
150	27.53	5.84	2.80	34.53	11.22	3.86	38.13	8.64	6.70	29.49	10.73	9.66	9.79	9.19	7.87	3.00
165	35.66	8.51	3.37	40.52	15.76	4.52	39.61	10.83	8.04	32.81	13.19	11.84	11.84	11.16	9.11	2.48
180	38.87	11.52	4.06	44.50	20.04	5.93	42.97	13.36	9.83	35.81	15.66	14.11	14.73	13.71	10.99	2.36
195	44.55	14.38	6.01	47.77	23.48	7.81	45.65	15.90	11.84	38.48	18.10	16.42	17.69	16.65	12.80	1.72
210	48.17	17.44	8.98	50.44	26.60	9.80	48.06	18.59	14.07	41.00	20.66	18.79	21.04	19.81	15.31	1.88
225	51.44	20.54	12.09	52.65	29.71	12.16	50.44	21.00	16.33	43.08	23.08	21.18	24.45	23.27	17.92	1.48
240	54.57	24.05	15.40	54.71	32.40	14.91	52.06	23.62	18.70	45.19	25.50	23.51	27.97	26.51	20.54	1.78
255	57.28	27.53	18.92	56.29	34.99	17.44	53.74	26.07	21.09	47.12	27.82	25.74	31.02	29.49	22.94	1.48
270	59.46	31.07	21.89	57.85	37.14	19.85	55.12	28.23	23.47	48.78	30.23	28.31	33.66	32.21	25.22	1.19
285	61.13	34.50	24.73	59.06	39.42	22.60	56.60	30.62	25.84	50.65	32.51	30.33	36.18	34.67	27.43	1.19
300	62.71	37.72	27.59	60.38	41.55	25.02	58.00	32.82	27.92	52.06	34.52	32.48	38.08	36.68	29.39	0.94
315	64.05	40.75	30.42	61.54	43.55	27.54	59.41	35.06	30.18	53.49	36.52	34.22	39.93	38.50	31.12	0.79
330	65.14	43.33	32.97	62.66	45.57	29.73	60.68	37.04	32.11	54.70	38.35	36.16	41.46	40.20	32.70	0.84
345	66.30	45.63	35.53	63.74	47.24	31.96	61.94	39.05	34.11	56.02	40.20	38.14	42.90	41.51	34.11	0.79
360	67.41	47.86	37.93	64.78	48.94	34.04	63.22	40.86	36.00	57.10	41.72	39.72	43.97	42.79	35.23	0.94
375	68.70	49.88	40.33	65.88	50.64	36.10	64.20	42.68	37.93	58.30	43.38	41.25	45.01	43.65	36.37	1.04
390	69.60	51.76	42.39	66.76	52.14	38.07	65.24	44.45	39.53	59.23	44.82	42.61	45.42	44.33	37.01	0.54
405	70.31	53.44	44.35	67.61	53.44	39.89	66.18	46.00	41.17	60.24	46.19	44.11	46.03	44.93	37.95	0.79
420	71.01	55.15	46.05	68.58	54.90	41.64	67.19	47.45	42.93	61.14	47.47	45.37	46.47	45.48	38.63	0.54
435	71.65	56.58	47.51	69.33	56.43	43.31	67.99	49.04	44.49	62.10	48.70	46.64	47.19	46.25	39.48	0.83
450	72.41	57.88	48.81	70.25	57.58	44.73	68.85	50.24	45.92	62.81	50.18	47.92	47.80	46.86	40.22	0.59
465	73.29	59.04	50.20	71.11	58.74	46.28	69.77	51.71	47.25	63.73	51.13	49.16	48.25	47.25	40.85	0.79
480	73.90	60.06	51.43	71.98	60.01	47.62	70.68	52.91	48.76	64.40	52.22	50.06	48.59	47.75	41.38	0.49
495	74.62	61.17	52.53	72.80	61.12	48.98	71.49	54.17	49.89	65.07	53.37	51.13	49.10	48.31	42.12	0.83
510	75.15	62.16	53.71	73.32	62.11	50.13	72.12	55.28	51.10	65.62	54.11	51.95	49.53	48.57	42.47	0.49
525	75.88	63.14	54.69	74.15	63.19	51.41	72.88	56.41	52.09	66.25	54.93	52.81	49.87	49.08	42.95	0.34
540	76.44	64.22	55.82	74.87	64.17	52.55	73.65	57.51	53.33	66.83	56.01	53.62	50.34	49.42	43.71	0.10
555	76.78	64.95	56.81	75.48	65.00	53.61	74.21	58.51	54.40	67.46	56.85	54.54	51.05	49.93	44.30	0.10
570	77.29	65.90	57.81	76.21	65.95	54.83	74.82	59.53	55.47	68.04	57.64	55.37	51.33	50.44	44.90	0.20
585	77.63	66.58	58.72	76.55	66.79	55.82	75.43	60.39	56.30	68.58	58.34	56.16	51.81	50.81	45.18	0.15
600	78.14	67.32	59.58	77.12	67.43	56.71	75.88	61.25	57.39	69.11	58.94	56.75	52.09	51.28	45.84	0.29
615	78.48	67.86	60.29	77.51	68.18	57.56	76.27	62.27	58.19	69.60	59.65	57.54	52.57	51.66	46.33	0.69
630	78.54	68.54	61.13	77.91	68.98	58.55	76.71	62.87	59.24	69.96	60.40	58.18	53.04	52.13	46.88	1.21
645	78.82	69.03	61.94	78.31	69.68	59.46	77.17	63.74	60.10	70.39	61.00	58.84	53.33	52.42	47.32	2.21
660	79.11	69.73	62.76	78.65	70.33	60.32	77.74	64.42	60.95	70.98	61.70	59.44	53.66	52.75	47.71	2.89
675	79.23	70.27	63.54	79.11	70.87	61.03	78.02	65.20	61.81	71.30	62.16	60.10	53.66	52.90	48.05	3.50
690	79.69	70.81	64.26	79.57	71.48	61.94	78.59	65.99	62.62	71.57	62.82	60.80	53.71	52.94	48.39	3.54
705	79.86	71.48	64.94	79.80	72.00	62.56	79.05	66.57	63.18	71.89	63.38	61.20	53.66	52.99	48.67	4.44
720	80.03	71.76	65.62	80.21	72.49	63.17	79.23	67.21	64.05	72.16	63.74	61.81	53.86	53.09	48.84	4.32
735	79.86	72.27	66.04	80.43	72.99	64.00	79.57	67.95	64.77	72.49	64.31	62.26	54.05	53.33	49.23	4.52
750	80.15	72.72	66.58	80.73	73.60	64.74	79.92	68.72	65.51	72.55	64.78	62.73	54.15	53.43	49.42	5.06
765	80.33	73.21	67.11	81.01	74.21	65.47	80.33	69.31	66.40	72.88	65.25	63.24	54.40	53.62	49.82	5.43
780	80.21	73.43	67.43	81.30	74.48	65.90	80.44	69.80	66.61	72.99	65.51	63.60	54.54	53.77	49.99	6.17
795	80.33	73.71	67.64	81.46	74.87	66.37	80.73	70.18	67.25	73.43	65.93	63.91	54.64	54.11	50.25	6.22
810	80.38	73.87	68.13	81.59	75.26	67.01	80.78	70.71	67.78	73.48	66.40	64.27	54.83	54.11	50.44	6.34
825	80.38	74.09	68.13	81.82	75.60	67.54	81.19	71.20	68.20	73.75	66.88	64.89	54.78	54.25	50.77	6.05
840	80.50	74.21	68.39	82.34	75.88	67.86	81.48	71.63	68.74	73.81	66.98	64.99	54.93	54.25	50.91	5.51
855	80.84	74.48	68.66	82.58	76.44	68.18	81.94	71.90	69.11	73.97	67.35	65.15	54.88	54.30	51.14	4.89
870	81.38	74.44	68.78	82.95	76.57	68.46	82.25	72.03	69.34	74.09	67.52	65.42	54.85	54.32	51.30	4.51
885	81.44	74.83	69.16	83.12	76.91	68.73	82.42	72.52	69.61	74.26	67.95	65.79	54.85	54.36	51.49	4.47
900	81.55	74.94	69.43	83.42	77.25	69.00	82.60	72.90	69.83	74.26	68.06	65.74	54.85	54.27	51.40	3.50

Cold Tub Experiment No. 2

Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	3.74	3.25	3.04	3.08	2.63	2.58	2.79	2.63	3.54	4.28	3.87	4.46	4.44	4.24	4.07	-0.10
15	3.70	3.25	2.98	6.53	2.71	2.50	2.83	2.63	3.46	4.28	3.58	4.44	4.61	4.44	4.32	-1.10
30	3.95	3.37	3.08	20.85	4.29	2.50	2.79	2.75	3.37	4.61	3.78	4.28	4.94	4.53	4.32	-1.70
45	9.13	3.41	3.12	29.89	7.91	2.58	2.79	2.58	3.41	8.66	3.82	4.36	5.19	4.90	4.44	-2.15
60	23.08	3.87	2.96	35.63	11.76	3.20	14.94	2.54	3.46	14.73	4.53	4.98	6.11	5.65	4.77	-1.60
75	28.39	5.76	3.20	39.75	15.95	3.83	22.48	3.29	3.46	20.32	5.90	6.11	7.67	7.08	5.44	-1.70
90	32.77	8.35	3.93	42.32	19.70	5.48	27.73	4.97	3.69	24.86	8.00	7.66	9.29	8.43	6.26	-2.12
105	37.10	10.79	5.02	44.85	22.53	7.23	33.18	6.67	4.35	28.87	10.33	9.72	10.63	9.59	7.02	-2.27
120	41.23	13.44	6.24	47.21	25.17	9.09	37.68	8.70	5.34	32.11	12.71	11.97	11.58	10.59	7.40	-2.27
135	46.98	16.02	8.22	49.65	27.53	11.06	41.29	11.14	6.77	34.76	15.16	14.31	12.76	11.80	8.26	-2.07
150	50.94	19.23	10.38	51.66	29.80	13.22	44.35	13.76	8.51	37.25	17.93	16.69	14.57	13.55	9.38	-1.97
165	54.25	22.67	12.88	53.56	32.06	15.38	46.92	16.39	10.41	39.70	20.30	19.09	16.60	15.52	10.93	-2.32
180	57.04	26.00	15.84	55.29	34.22	17.64	49.12	18.71	12.67	41.56	22.77	21.36	18.76	17.66	12.63	-2.42
195	59.17	29.44	18.81	56.69	36.30	19.70	51.14	21.30	14.89	43.50	24.91	23.62	20.95	19.74	14.35	-2.46
210	61.66	33.24	22.52	58.39	38.79	22.33	53.32	24.19	17.77	45.56	27.61	26.15	23.33	22.16	16.81	-1.67
225	63.51	36.45	25.48	59.72	40.67	24.53	54.79	26.67	20.17	47.39	29.79	28.25	25.23	23.99	18.55	-1.02
240	65.08	39.71	28.85	60.89	42.66	26.67	56.48	28.90	22.53	48.85	31.82	30.24	27.27	26.01	20.58	0.31
255	66.62	42.56	32.37	62.12	44.36	28.80	57.73	31.21	24.80	50.51	33.79	32.12	28.94	27.71	22.11	1.06
270	68.12	44.97	35.48	63.30	46.03	30.91	59.00	33.13	27.42	51.79	35.74	33.99	29.99	28.89	23.47	1.73
285	69.64	47.61	38.58	64.29	47.76	33.03	60.23	35.40	29.54	53.08	37.51	35.63	30.73	29.49	24.23	2.06
300	70.89	49.95	41.47	65.45	49.52	35.09	61.40	37.35	31.87	54.39	39.10	37.19	31.08	30.04	25.04	2.42
315	71.98	52.30	44.03	66.19	50.95	36.93	62.68	39.44	33.99	55.51	40.74	38.83	31.42	30.48	25.87	3.07
330	73.11	54.16	46.40	67.13	52.36	38.65	63.43	41.01	35.63	56.10	41.87	39.85	31.35	30.26	25.77	3.20
345	73.89	56.14	48.47	67.99	53.77	40.64	64.43	42.85	37.56	57.24	43.17	41.28	31.45	30.61	26.01	4.10
360	74.90	58.11	50.72	68.86	55.05	42.15	65.48	44.61	39.47	58.25	44.75	42.68	31.80	30.95	26.55	4.88
375	75.68	59.79	52.50	69.57	56.34	43.84	66.49	46.34	41.28	59.11	46.02	43.93	32.41	31.55	27.28	4.84
390	76.36	61.42	54.31	70.33	57.60	45.50	67.34	47.81	42.84	59.92	47.31	44.97	33.21	32.30	27.87	5.63
405	77.10	62.86	55.69	71.09	58.82	47.02	68.42	49.34	44.58	60.83	48.49	46.30	34.03	33.01	28.66	5.67
420	77.85	64.16	57.30	71.74	59.85	48.38	69.18	50.82	46.08	61.64	49.68	47.31	34.34	33.37	29.31	6.14
435	78.54	65.43	58.82	72.29	61.07	49.72	69.84	52.16	47.59	62.30	50.63	48.26	34.64	33.67	29.81	6.18
450	78.89	66.47	59.81	72.83	61.75	50.72	70.26	53.33	48.75	63.04	51.54	49.15	34.76	33.79	30.02	5.69
465	79.29	67.59	60.78	73.44	62.68	52.02	71.02	54.41	50.21	63.66	52.55	49.93	34.76	34.10	30.52	5.44
480	79.88	68.51	61.85	73.77	63.72	53.04	71.84	55.55	51.25	64.34	53.42	50.87	35.02	34.35	30.82	5.15
495	80.34	69.44	62.84	74.44	64.51	54.07	72.50	56.60	52.21	64.91	54.24	51.54	35.23	34.45	31.21	4.89
510	80.86	70.42	63.82	75.00	65.40	55.06	73.22	57.61	53.48	65.54	54.98	52.35	35.38	34.56	31.48	5.07
525	81.27	71.24	64.51	75.45	66.04	56.05	73.72	58.78	54.39	66.01	55.77	52.98	35.38	34.78	31.81	5.11
540	81.62	71.89	65.19	75.96	66.73	56.96	74.22	59.60	55.32	66.44	56.36	53.66	35.69	35.02	31.96	5.36
555	81.91	72.50	65.93	76.36	67.49	57.71	74.83	60.47	56.16	66.86	57.06	54.34	35.90	35.28	32.37	4.78
570	82.08	73.04	66.29	76.69	68.07	58.36	75.22	61.32	56.93	67.11	57.48	54.75	35.98	35.25	32.54	4.83
585	82.55	73.59	66.72	77.09	68.77	59.02	75.61	61.94	57.63	67.54	58.09	55.19	36.19	35.35	32.84	5.80
600	82.84	74.04	67.09	77.26	69.26	59.64	75.95	62.77	58.54	67.86	58.49	55.83	36.29	35.72	33.04	6.46
615	83.08	74.49	67.47	77.72	69.87	60.15	76.29	63.44	59.10	68.13	59.10	56.33	36.66	35.82	33.50	5.66
630	83.37	74.82	67.85	78.01	70.35	60.81	76.69	64.02	59.76	68.35	59.66	56.68	36.71	36.19	33.81	6.29
645	83.67	75.22	68.17	78.41	70.84	61.43	76.98	64.65	60.37	68.51	60.07	57.23	37.13	36.45	34.06	5.78
660	84.03	75.61	68.45	78.65	71.33	61.99	77.26	65.18	61.13	68.83	60.52	57.68	37.24	36.50	34.37	5.87
675	84.27	75.95	68.88	78.88	71.66	62.51	77.49	65.87	61.69	69.16	60.93	58.19	37.45	36.81	34.63	6.59
690	84.33	76.30	69.28	79.06	72.11	63.04	77.85	66.36	62.27	69.60	61.45	58.61	37.79	37.16	34.91	5.88
705	84.63	76.53	69.39	79.41	72.55	63.46	78.08	66.79	62.63	69.88	61.56	58.71	37.90	37.37	35.48	6.09
720	84.63	76.76	69.77	79.53	72.77	63.88	78.25	67.27	63.30	70.04	62.22	59.22	38.21	37.84	35.64	6.09
735	84.69	76.99	70.04	79.70	73.11	64.35	78.31	67.81	63.82	70.15	62.53	59.53	38.37	37.74	35.90	5.71
750	84.75	77.21	70.26	79.88	73.44	64.66	78.48	68.08	64.28	70.31	62.58	59.89	38.53	38.00	36.00	5.75
765	84.81	77.39	70.64	79.99	73.72	65.14	78.71	68.57	64.54	70.56	62.89	60.24	38.80	38.27	36.42	4.63
780	84.99	77.50	70.69	80.22	73.99	65.40	78.71	68.79	64.91	70.74	63.30	60.49	38.85	38.53	36.74	6.47
795	85.05	77.85	71.02	80.28	74.27	65.58	79.00	69.22	65.38	70.74	63.45	60.74	39.17	38.59	36.84	4.63
810	84.74	77.82	71.09	80.26	74.19	65.62	78.69	69.18	65.54	70.86	63.56	60.89	39.16	38.73	36.98	5.35
825	84.92	77.82	71.42	80.26	74.47	66.04	78.98	69.51	65.80	71.02	63.82	61.14	39.43	38.79	37.19	3.98
840	84.86	78.05	71.64	80.38	74.69	66.20	79.15	69.84	66.17	71.07	64.18	61.25	39.48	39.22	37.51	4.31
855	84.98	78.11	71.86	80.43	74.75	66.53	79.10	70.00	66.44	71.18	64.28	61.55	39.86	39.22	37.77	5.35
870	84.92	78.40	72.08	80.32	75.03	66.79	79.27	70.27	66.87	71.40	64.54	61.76	40.08	39.48	37.99	4.52
885	84.86	78.46	72.24	80.49	75.14	67.12	79.27	70.54	67.19	71.45	64.75	61.96	40.13	39.66	38.41	3.57
900	85.04	78.46	72.30	80.49	75.08	67.33	79.21	70.82	67.40	71.56	64.86	62.06	40.50	40.02	38.36	4.56

Cold Tub Experiment No. 3

Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	3.61	2.99	3.02	3.95	3.09	2.51	3.76	2.79	3.57	5.87	5.03	5.09	6.02	6.08	6.29	6.53
15	3.97	3.06	3.10	3.93	3.14	2.63	3.78	2.86	3.74	5.94	5.14	5.21	6.15	6.16	6.37	3.48
30	4.20	3.20	3.18	3.98	3.20	2.73	3.83	2.97	3.83	5.97	5.25	5.29	6.27	6.28	6.43	1.10
45	4.20	3.31	3.20	4.74	3.30	2.75	3.96	3.03	3.90	6.03	5.35	5.37	6.40	6.39	6.50	0.08
60	4.35	3.44	3.22	12.42	3.75	2.75	4.12	3.11	3.95	6.06	5.42	5.44	6.57	6.52	6.57	-0.10
75	4.43	3.55	3.26	24.83	8.22	2.81	4.63	3.22	4.00	6.11	5.45	5.48	6.89	6.66	6.65	-0.14
90	8.52	3.68	3.36	31.13	10.81	3.14	15.18	3.37	4.10	6.49	5.51	5.57	6.93	6.87	6.77	-0.60
105	11.99	3.84	3.03	33.11	14.36	3.28	23.65	3.59	3.97	8.91	5.42	5.43	7.09	7.00	6.70	-1.25
120	16.06	4.45	3.13	35.26	17.23	4.24	30.62	5.05	4.27	7.81	5.59	5.56	7.89	7.71	7.00	-1.62
135	17.27	5.50	3.34	38.66	19.48	5.39	36.44	7.05	5.00	8.33	5.85	5.72	8.96	8.62	7.39	-1.21
150	17.00	6.68	3.76	41.91	21.87	6.83	40.63	9.35	5.97	9.12	6.18	6.00	10.11	9.63	7.95	-1.41
165	16.00	7.59	4.30	44.15	24.22	8.31	44.06	11.75	7.20	9.87	6.57	6.33	11.09	10.54	8.47	-1.56
180	15.11	8.30	5.00	46.05	26.41	9.93	46.71	14.22	8.82	10.69	7.05	6.81	11.99	11.39	9.02	-1.55
195	14.28	8.78	5.69	48.02	28.41	11.58	48.97	16.71	10.60	11.47	7.58	7.30	12.81	12.20	9.54	-1.35
210	13.67	9.11	6.36	49.83	30.34	13.29	50.98	19.11	12.57	12.20	8.11	7.85	13.73	13.10	10.15	-0.58
225	13.87	9.77	7.44	51.89	32.64	15.51	53.13	21.89	14.79	13.12	8.83	8.65	15.04	14.33	11.09	-0.11
240	14.15	10.05	8.02	53.55	34.50	17.35	54.73	24.16	17.01	14.00	9.49	9.34	16.36	15.59	12.05	0.63
255	15.29	10.28	8.51	55.06	36.31	19.20	56.19	26.27	19.19	14.82	10.17	10.12	17.84	17.02	13.11	0.82
270	17.01	10.69	8.99	56.50	38.07	21.03	57.49	28.48	21.37	15.75	10.93	10.96	19.53	18.61	14.32	1.47
285	19.54	11.24	9.47	57.86	39.77	22.83	58.74	30.47	23.56	16.67	11.74	11.82	21.31	20.33	15.67	1.82
300	22.57	11.99	9.96	59.13	41.42	24.64	59.91	32.50	25.71	17.64	12.55	12.76	23.04	22.01	17.12	2.05
315	24.38	12.91	10.47	60.28	42.99	26.40	60.99	34.41	27.80	18.61	13.40	13.71	24.75	23.65	18.54	2.61
330	24.90	13.87	11.06	61.39	44.47	28.14	62.06	36.27	29.84	19.61	14.31	14.72	26.37	25.26	19.94	2.92
345	25.18	15.00	11.98	62.67	46.16	30.02	63.27	38.25	31.84	20.71	15.30	15.84	28.01	26.87	21.42	3.20
360	25.10	15.81	12.76	63.89	47.55	31.64	64.23	39.92	33.67	21.71	16.26	16.91	29.53	28.38	22.79	3.60
375	24.87	16.55	13.58	64.72	48.94	33.27	65.19	41.54	35.43	22.81	17.26	18.05	31.02	29.89	24.22	3.56
390	24.75	17.18	14.35	65.62	50.25	34.79	66.08	43.07	37.11	23.93	18.30	19.15	32.40	31.27	25.56	4.12
405	25.17	17.79	15.20	66.44	51.48	36.31	66.94	44.56	38.75	25.06	19.34	20.28	33.65	32.54	26.86	4.10
420	26.97	18.45	15.95	67.25	52.67	37.81	67.74	46.02	40.34	26.24	20.43	21.45	34.90	33.77	28.11	4.55
435	30.75	19.34	16.78	67.99	53.80	39.25	68.54	47.37	41.80	27.44	21.50	22.59	35.86	34.76	29.15	4.62
450	34.27	20.57	17.58	68.76	54.90	40.65	69.32	48.68	43.20	28.63	22.65	23.77	36.60	35.53	30.04	4.53
465	37.63	22.06	18.49	69.52	56.00	41.96	70.04	49.97	44.57	29.89	23.82	25.01	37.24	36.24	30.85	4.23
480	40.66	23.64	19.48	70.18	57.02	43.22	70.71	51.11	45.77	31.11	24.96	26.14	37.78	36.80	31.53	3.75
495	43.03	25.37	20.55	70.81	57.99	44.46	71.32	52.23	46.96	32.38	26.13	27.32	38.36	37.41	32.17	3.38
510	45.27	27.10	21.70	71.36	58.87	45.50	71.90	53.27	48.05	33.60	27.27	28.45	38.96	38.04	32.85	2.85
525	47.39	28.85	22.92	71.93	59.78	46.58	72.47	54.25	49.07	34.85	28.48	29.60	39.60	38.70	33.52	2.53
540	49.50	30.61	24.24	72.48	60.61	47.62	73.00	55.18	50.10	36.15	29.65	30.76	40.31	39.41	34.24	2.39
555	52.83	32.41	25.68	72.99	61.39	48.64	73.50	56.08	51.03	37.43	30.82	31.89	40.93	40.03	34.88	2.24
570	56.63	34.40	27.35	73.49	62.17	49.56	73.97	56.93	51.95	38.69	31.99	33.00	41.47	40.62	35.51	1.86
585	60.12	36.67	29.99	74.04	62.99	50.58	74.48	57.87	52.78	39.92	33.14	34.13	42.04	41.18	36.09	1.79
600	62.18	39.03	32.87	74.46	63.68	51.54	74.91	58.65	53.61	41.19	34.31	35.25	42.52	41.68	36.70	1.98
615	64.17	41.51	35.48	74.80	64.33	52.40	75.26	59.34	54.35	42.33	35.44	36.30	42.79	41.95	37.10	1.58
630	65.77	43.98	38.21	75.17	64.95	53.22	75.61	60.04	55.07	43.50	36.59	37.38	43.28	42.46	37.61	2.04
645	67.03	46.45	40.75	75.52	65.58	54.11	75.95	60.66	55.79	44.64	37.74	38.44	43.82	43.00	38.18	1.61
660	68.32	48.82	43.18	75.86	66.17	54.93	76.27	61.29	56.47	45.74	38.86	39.51	44.35	43.54	38.75	1.24
675	69.43	51.04	45.47	76.17	66.74	55.68	76.60	61.86	57.12	46.75	39.92	40.50	44.81	44.02	39.28	1.52
690	70.35	53.10	47.65	76.48	67.25	56.45	76.88	62.41	57.72	47.74	40.99	41.44	45.24	44.46	39.78	1.82
705	71.25	55.22	49.66	76.90	67.95	57.25	77.26	63.04	58.36	48.73	42.10	42.48	45.78	45.01	40.34	1.62
720	72.03	56.95	51.39	77.18	68.41	57.86	77.48	63.54	58.90	49.58	43.04	43.37	46.15	45.40	40.82	1.49
735	72.85	58.58	52.97	77.45	68.89	58.52	77.74	64.00	59.40	50.38	43.98	44.23	46.36	45.63	41.22	1.23
750	73.74	60.04	54.43	77.66	69.36	59.20	77.97	64.44	59.90	51.14	44.88	45.03	46.45	45.74	41.45	1.59
765	74.47	61.38	55.90	77.91	69.78	59.78	78.18	64.86	60.41	51.86	45.74	45.81	46.73	46.04	41.75	1.47
780	75.14	62.66	57.15	78.14	70.20	60.21	78.35	65.27	60.84	52.56	46.54	46.53	47.08	46.39	42.08	1.98
795	75.61	63.82	58.27	78.36	70.57	60.73	78.54	65.63	61.25	53.22	47.30	47.25	47.41	46.75	42.47	1.47
810	76.10	64.83	59.13	78.58	70.93	61.20	78.67	65.96	61.64	53.83	48.04	47.87	47.63	46.98	42.82	1.21
825	76.64	65.79	60.03	78.82	71.33	61.66	78.87	66.32	62.05	54.43	48.76	48.53	47.75	47.11	43.06	1.67
840	77.12	66.65	60.90	79.01	71.65	62.02	79.06	66.65	62.38	55.00	49.44	49.14	48.03	47.40	43.34	1.58
855	77.26	67.42	61.70	79.18	71.98	62.41	79.27	66.97	62.75	55.54	50.09	49.73	48.32	47.68	43.66	1.73
870	77.92	68.14	62.30	79.33	72.23	62.81	79.41	67.25	63.14	56.04	50.71	50.26	48.50	47.86	43.93	1.37
885	78.49	68.83	63.06	79.46	72.56	63.21	79.58	67.56	63.46	56.57	51.31	50.82	48.49	47.88	44.15	1.50
900	78.47	69.43	63.55	79.60	72.80	63.57	79.72	67.82	63.69	57.02	51.84	51.28	48.57	47.97	44.25	1.40

Cold Tub Experiment No. 4

Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	3.36	3.05	2.96	3.76	3.63	3.50	4.85	4.79	5.06	6.38	6.22	6.30	5.92	5.90	5.66	11.83
15	3.66	3.07	2.96	3.77	3.63	3.58	4.86	4.84	5.16	6.42	6.25	6.33	5.96	5.96	5.73	7.80
30	3.81	3.17	3.03	3.75	3.62	3.60	4.85	4.85	5.15	6.39	6.23	6.32	5.99	5.96	5.72	5.32
45	3.41	2.74	2.57	3.29	3.18	3.18	4.38	4.39	5.20	6.42	6.27	6.34	6.03	6.01	5.78	4.45
60	3.45	2.81	2.59	3.29	3.17	3.16	4.37	4.39	5.18	6.41	6.26	6.35	6.06	6.05	5.79	4.04
75	3.50	2.87	2.66	3.33	3.21	3.16	4.39	4.38	5.19	6.75	6.25	6.34	6.14	6.11	5.83	3.54
90	3.52	2.92	2.87	3.37	3.20	3.16	4.45	4.35	5.15	11.54	6.35	6.38	6.39	6.35	5.95	2.83
105	3.52	2.95	2.70	3.47	3.23	3.12	11.83	4.36	5.14	17.59	7.08	6.78	7.08	6.98	6.28	1.83
120	3.52	2.98	2.73	4.25	3.32	3.13	24.43	4.41	5.14	22.95	8.66	7.82	8.20	7.99	6.90	1.14
135	3.50	3.06	2.79	8.00	3.55	3.06	32.94	4.83	5.30	27.50	10.86	9.57	9.92	9.55	7.83	1.06
150	3.56	3.09	2.85	17.93	4.56	3.06	36.66	5.86	5.89	31.33	13.36	11.75	12.85	12.23	9.52	0.41
165	3.90	3.47	3.21	27.50	7.39	3.42	43.48	7.78	6.95	34.62	16.13	14.31	16.78	15.84	12.12	0.60
180	3.90	3.54	3.25	33.49	10.90	3.73	46.66	9.69	8.42	37.50	18.88	16.93	20.81	19.70	15.08	0.66
195	3.95	3.52	3.25	37.22	14.33	4.32	49.27	11.84	10.24	40.09	21.60	19.61	24.83	23.34	18.03	0.54
210	4.27	3.58	3.30	39.74	17.32	5.31	51.41	14.15	12.26	42.39	24.24	22.23	28.29	26.91	21.01	0.40
225	4.44	3.63	3.31	41.66	19.89	6.51	53.22	16.54	14.46	44.48	26.80	24.77	31.62	30.25	23.87	0.44
240	4.90	3.70	3.33	43.22	22.12	7.94	54.77	18.95	16.67	46.40	29.25	27.19	34.61	33.24	26.58	0.36
255	5.14	3.80	3.36	44.43	24.13	9.44	56.26	21.33	19.00	48.22	31.53	29.52	37.32	35.96	29.07	0.56
270	5.25	3.92	3.43	45.46	25.93	11.00	57.57	23.62	21.23	49.87	33.71	31.74	39.74	38.43	31.42	0.41
285	5.47	4.19	3.67	46.61	27.81	12.73	58.95	26.03	23.46	51.48	35.78	33.81	41.90	40.67	33.56	0.57
300	5.57	4.33	3.75	47.39	29.36	14.29	60.15	28.24	25.64	52.98	37.76	35.77	43.89	42.71	35.58	0.18
315	5.72	4.48	3.86	48.11	30.76	15.87	61.23	30.32	27.72	54.36	39.60	37.62	45.65	44.48	37.34	0.19
330	5.90	4.64	3.98	48.83	32.10	17.37	62.25	32.29	29.71	55.69	41.30	39.36	47.25	46.14	39.04	0.22
345	6.20	4.81	4.16	49.37	33.32	18.85	63.22	34.18	31.60	56.92	42.93	41.01	48.70	47.63	40.58	-0.22
360	6.53	5.02	4.31	49.79	34.49	20.27	64.16	36.03	33.45	58.13	44.47	42.55	50.02	49.01	42.02	0.18
375	6.98	5.24	4.52	50.12	35.55	21.61	65.11	37.78	35.20	59.29	45.94	44.02	51.21	50.26	43.39	-0.03
390	7.48	5.48	4.70	50.47	36.50	22.84	66.00	39.41	36.88	60.39	47.32	45.39	52.29	51.40	44.63	-0.16
405	7.95	5.76	4.91	50.84	37.43	24.08	66.84	40.99	38.48	61.43	48.64	46.71	53.37	52.51	45.86	0.01
420	8.33	6.04	5.15	51.16	38.27	25.19	67.63	42.45	39.98	62.39	49.88	47.96	54.45	53.61	47.07	-0.15
435	8.65	6.36	5.40	51.56	39.14	26.31	68.43	43.91	41.45	63.37	51.11	49.19	55.52	54.69	48.26	-0.04
450	8.85	6.68	5.68	51.86	39.95	27.35	69.13	45.27	42.83	64.27	52.24	50.32	56.50	55.71	49.38	-0.43
465	9.00	6.99	6.01	52.28	40.70	28.39	69.84	46.60	44.19	65.12	53.33	51.45	57.57	56.78	50.55	0.01
480	9.04	7.25	6.32	52.81	41.43	29.40	70.46	47.83	45.45	65.92	54.37	52.46	58.53	57.77	51.64	0.14
495	9.29	7.53	6.58	53.46	42.19	30.26	71.12	49.00	46.66	66.68	55.34	53.46	59.44	58.71	52.84	-0.21
510	9.45	7.80	6.93	54.12	42.94	31.18	71.74	50.16	47.84	67.43	56.34	54.43	60.31	59.57	53.83	0.00
525	9.66	8.07	7.26	54.78	43.71	32.02	72.33	51.23	48.94	68.08	57.22	55.31	61.06	60.37	54.46	0.73
540	9.76	8.35	7.57	55.42	44.45	32.95	72.89	52.29	50.01	68.74	58.09	56.21	61.78	61.12	55.39	1.37
555	9.74	8.60	7.90	56.05	45.19	33.84	73.44	53.29	51.09	69.38	58.94	57.06	62.50	61.84	56.21	2.09
570	9.79	8.82	8.18	56.74	45.94	34.75	73.96	54.25	52.12	69.97	59.74	57.90	63.20	62.56	57.00	2.17
585	9.90	9.04	8.48	57.41	46.68	35.72	74.48	55.19	53.07	70.50	60.53	58.69	63.87	63.25	57.75	2.45
600	10.17	9.27	8.81	58.14	47.46	36.62	75.01	56.10	54.02	71.04	61.26	59.43	64.49	63.89	58.50	3.14
615	10.36	9.47	9.08	58.87	48.20	37.44	75.48	56.96	54.90	71.53	61.96	60.15	65.10	64.49	59.19	3.50
630	10.90	9.76	9.37	59.62	48.97	38.29	75.92	57.80	55.81	72.05	62.65	60.86	65.67	65.06	59.81	3.81
645	11.22	10.05	9.72	60.23	49.80	39.16	76.42	58.67	56.65	72.52	63.33	61.52	66.23	65.61	60.46	4.28
660	11.36	10.36	10.03	60.73	50.54	39.97	76.82	59.45	57.46	72.96	63.95	62.15	66.76	66.17	61.06	5.02
675	11.56	10.63	10.31	61.22	51.22	40.72	77.22	60.18	58.19	73.40	64.54	62.77	67.26	66.64	61.61	4.94
690	11.74	10.90	10.62	61.65	51.87	41.47	77.60	60.86	58.90	73.80	65.12	63.36	67.72	67.14	62.14	5.37
705	11.90	11.14	10.93	62.11	52.48	42.18	77.93	61.50	59.58	74.22	65.67	63.89	68.18	67.59	62.66	5.54
720	12.18	11.39	11.24	62.57	53.09	42.88	78.26	62.13	60.25	74.59	66.19	64.44	68.59	68.00	63.14	5.45
735	12.44	11.65	11.53	63.03	53.67	43.49	78.53	62.70	60.81	74.92	66.65	64.93	68.92	68.36	63.54	4.97
750	12.76	11.94	11.80	63.49	54.26	44.10	78.84	63.27	61.40	75.27	67.13	65.40	69.30	68.75	63.95	5.02
765	13.04	12.30	12.14	64.00	54.87	44.69	79.16	63.85	61.97	75.64	67.64	65.91	69.65	69.07	64.34	4.69
780	13.23	12.57	12.42	64.44	55.44	45.25	79.42	64.33	62.45	75.97	68.07	66.34	69.93	69.40	64.80	4.88
795	13.46	12.90	12.75	64.83	55.99	45.79	79.69	64.81	62.91	76.25	68.48	66.75	70.18	69.61	64.86	4.05
810	13.73	13.12	13.00	65.11	56.46	46.27	79.88	65.18	63.27	76.52	68.81	67.06	70.38	69.83	65.05	3.78
825	14.04	13.45	13.30	65.37	56.93	46.77	80.06	65.58	63.68	76.77	69.15	67.39	70.58	70.04	65.26	3.63
840	14.33	13.76	13.64	65.58	57.37	47.30	80.26	66.00	64.08	77.04	69.50	67.78	70.84	70.28	65.51	3.88
855	14.59	14.05	13.92	65.81	57.75	47.72	80.38	66.33	64.40	77.24	69.80	68.06	71.06	70.50	65.73	3.27
870	14.88	14.34	14.23	65.99	58.09	48.18	80.53	66.66	64.80	77.46	70.10	68.38	71.32	70.75	66.00	3.26
885	15.17	14.60	14.47	66.17	58.37	48.58	80.64	66.97	65.16	77.64	70.38	68.68	71.55	70.96	66.21	3.40
900	15.47	14.90	14.78	66.34	58.69	48.99	80.68	67.27	65.41	77.84	70.62	68.94	71.74	71.17	66.42	3.41

Cold Tub Experiment No. 5

Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0	3.35	2.63	2.54	3.01	2.92	2.87	3.32	3.35	3.99	4.84	4.68	4.82	4.79	4.72	4.49	10.48
15	3.53	2.70	2.60	3.04	2.92	2.89	3.34	3.36	4.04	4.86	4.73	4.85	4.86	4.82	4.52	5.71
30	3.65	2.80	2.63	3.05	2.94	2.88	3.35	3.40	4.02	4.85	4.74	4.84	4.89	4.90	4.58	3.68
45	3.68	2.87	2.64	3.10	2.95	2.91	3.38	3.43	4.03	4.91	4.75	4.87	5.13	5.05	4.69	2.85
60	3.73	2.95	2.68	3.59	2.98	2.90	3.49	3.42	4.01	7.49	4.78	4.88	5.39	5.32	4.83	1.94
75	3.69	3.00	2.71	9.27	3.26	2.90	14.82	3.40	3.98	13.80	5.26	5.07	6.00	5.89	5.13	1.54
90	3.08	2.45	2.16	16.68	4.16	2.34	24.20	2.92	3.75	19.41	6.47	5.72	7.00	6.75	5.55	1.02
105	3.06	2.51	2.22	23.82	8.58	2.45	30.07	3.31	3.84	24.53	8.69	7.41	8.95	8.52	6.56	0.61
120	3.06	2.54	2.26	29.81	9.18	2.76	34.35	4.17	4.18	28.78	11.34	9.63	11.39	10.76	8.00	0.41
135	3.04	2.59	2.30	34.67	12.27	3.35	38.29	5.50	4.93	32.49	14.27	12.30	14.34	13.52	9.85	0.25
150	3.03	2.62	2.32	38.35	15.33	4.25	41.39	7.18	6.06	35.68	17.26	15.09	17.32	16.33	11.88	0.18
165	2.99	2.64	2.33	41.21	18.23	5.43	44.02	9.14	7.57	38.51	20.25	17.92	20.16	19.07	13.85	-0.11
180	2.99	2.65	2.39	43.71	20.94	6.88	46.26	11.27	9.38	41.04	23.08	20.72	22.77	21.65	15.98	0.01
195	3.02	2.69	2.41	46.07	23.51	8.59	48.11	13.51	11.36	43.30	25.84	23.41	25.04	23.88	17.83	0.19
210	3.24	2.86	2.66	48.38	26.16	10.59	50.05	16.02	13.42	45.27	28.43	25.95	26.92	25.78	19.55	-0.06
225	7.62	2.96	2.72	50.32	28.58	12.50	51.79	18.37	15.65	47.04	30.89	28.37	28.56	27.48	21.16	-0.34
240	18.65	3.39	2.77	52.07	30.79	14.44	53.30	20.65	17.86	48.58	33.11	30.62	30.07	29.00	22.63	-0.24
255	23.44	4.68	2.87	53.65	32.87	16.44	54.76	22.90	20.10	50.03	35.17	32.57	31.45	30.45	24.05	0.00
270	27.86	8.53	3.14	55.05	34.92	18.48	56.14	25.11	22.28	51.38	37.13	34.49	32.83	31.83	25.48	-0.07
285	30.26	8.52	3.69	56.26	36.83	20.51	57.44	27.27	24.43	52.64	38.90	36.21	34.19	33.20	26.90	-0.22
300	32.36	10.41	4.51	57.34	38.61	22.45	58.65	29.34	26.49	53.84	40.51	37.82	35.43	34.48	28.22	-0.13
315	33.74	12.19	5.54	58.33	40.29	24.32	59.81	31.31	28.53	54.94	42.03	39.29	36.60	35.65	29.49	-0.48
330	34.78	13.95	6.81	59.36	41.95	26.27	60.95	33.32	30.52	56.09	43.46	40.75	37.77	36.85	30.73	-0.28
345	34.37	15.46	8.09	60.23	43.46	28.08	61.94	35.14	32.38	57.11	44.81	42.07	38.83	37.92	31.89	-0.40
360	33.51	16.77	9.45	61.03	44.84	29.79	62.86	36.89	34.17	58.09	46.06	43.33	39.75	38.90	32.94	-0.43
375	32.28	17.79	10.78	61.79	46.18	31.42	63.75	38.58	35.91	59.00	47.26	44.52	40.60	39.75	33.87	-0.46
390	31.36	18.63	12.07	62.55	47.45	33.01	64.61	40.22	37.55	59.87	48.42	45.65	41.33	40.53	34.77	-0.85
405	30.30	19.28	13.28	63.34	48.67	34.53	65.42	41.76	39.14	60.66	49.51	46.74	41.98	41.20	35.58	-0.72
420	29.34	19.80	14.34	64.05	49.81	35.94	66.19	43.18	40.60	61.41	50.48	47.75	42.59	41.84	36.34	-0.28
435	28.54	20.22	15.33	64.72	50.89	37.34	66.93	44.53	41.99	62.16	51.44	48.72	43.15	42.43	37.04	-0.27
450	27.85	20.60	16.25	65.46	51.98	38.70	67.67	45.92	43.37	62.89	52.35	49.65	43.68	43.00	37.74	-0.50
465	27.24	20.89	17.00	66.07	52.97	39.94	68.28	47.15	44.65	63.57	53.21	50.52	44.18	43.52	38.38	-0.37
480	26.84	21.13	17.67	66.72	53.91	41.11	68.88	48.36	45.87	64.18	54.01	51.33	44.68	44.04	38.97	-0.72
495	26.53	21.30	18.24	67.33	54.81	42.20	69.45	49.48	46.94	64.79	54.76	52.08	45.11	44.50	39.56	-0.26
510	26.36	21.55	18.77	67.98	55.70	43.26	69.98	50.53	48.06	65.35	55.53	52.84	45.55	44.95	40.11	-0.21
525	26.32	21.75	19.28	68.58	56.57	44.33	70.20	51.52	49.12	65.92	56.27	53.59	45.97	45.39	40.61	-0.10
540	26.36	21.98	19.66	69.16	57.38	45.29	70.85	52.46	50.08	66.40	56.91	54.25	46.34	45.75	41.06	-0.07
555	26.45	22.22	20.06	69.67	58.18	46.25	71.34	53.37	51.01	66.89	57.56	54.89	46.74	46.17	41.50	-0.05
570	26.53	22.43	20.40	70.09	58.90	47.08	71.80	54.21	51.85	67.31	58.13	55.49	47.05	46.50	41.93	0.09
585	26.68	22.73	20.79	70.55	59.59	47.95	72.25	55.00	52.62	67.72	58.73	56.07	47.33	46.80	42.30	-0.01
600	27.06	22.99	21.13	70.97	60.26	48.76	72.68	55.78	53.40	68.10	59.27	56.63	47.55	47.03	42.61	0.05
615	27.48	23.31	21.49	71.32	60.88	49.51	73.10	56.53	54.17	68.45	59.80	57.20	47.79	47.29	42.94	0.06
630	27.91	23.67	21.82	71.64	61.46	50.20	73.47	57.23	54.87	68.80	60.29	57.67	47.95	47.45	43.19	-0.07
645	28.23	24.00	22.17	71.95	61.97	50.88	73.79	57.89	55.54	69.12	60.72	58.14	48.17	47.73	43.49	0.06
660	28.60	24.37	22.52	72.22	62.47	51.55	74.12	58.56	56.28	69.41	61.16	58.60	48.34	47.86	43.76	0.00
675	29.16	24.72	22.89	72.52	62.95	52.15	74.45	59.15	56.83	69.68	61.56	59.03	48.38	47.92	43.94	0.03
690	29.80	25.13	23.26	72.76	63.41	52.76	74.78	59.72	57.48	69.98	62.01	59.48	48.44	47.98	44.13	0.14
705	30.43	25.55	23.62	72.98	63.85	53.24	75.04	60.28	57.92	70.23	62.39	59.87	48.45	47.98	44.21	0.15
720	31.01	26.01	24.01	73.25	64.26	53.79	75.18	60.65	58.32	70.48	62.77	60.26	48.51	48.05	44.34	0.01
735	31.19	26.47	24.41	73.48	64.65	54.34	75.45	61.15	58.86	70.70	63.10	60.58	48.77	48.35	44.65	0.25
750	31.41	26.85	24.78	73.69	64.97	54.78	75.64	61.64	59.47	70.86	63.38	60.85	48.93	48.50	44.88	0.04
765	31.95	27.29	25.23	73.94	65.34	55.21	75.85	62.11	59.95	71.08	63.69	61.18	49.02	48.64	45.13	0.11
780	32.79	27.67	25.61	74.15	65.64	55.62	76.01	62.51	60.39	71.22	63.95	61.29	49.03	48.63	45.21	0.29
795	33.98	28.14	25.98	74.32	65.98	55.98	76.17	62.93	60.86	71.34	64.20	61.57	49.00	48.60	45.31	0.24
810	34.60	28.63	26.32	74.40	66.20	56.26	76.27	63.25	61.17	71.36	64.32	61.72	48.97	48.58	45.30	0.18
825	34.74	29.19	26.72	74.55	66.48	56.62	76.41	63.58	61.48	71.48	64.56	61.96	49.23	48.85	45.55	0.26
840	34.83	29.67	27.16	74.71	66.77	56.95	76.53	63.83	61.64	71.59	64.77	62.18	49.46	49.09	45.82	0.16
855	34.87	30.09	27.58	74.81	66.96	57.28	76.61	64.06	62.00	71.66	64.96	62.36	49.69	49.37	46.11	0.13
870	35.00	30.48	28.07	74.96	67.23	57.55	76.72	64.42	62.37	71.76	65.16	62.60	49.95	49.62	46.43	0.31
885	35.19	30.81	28.46	75.14	67.45	57.79	76.78	64.68	62.59	71.83	65.31	62.74	50.24	49.92	46.72	0.43
900	35.50	31.15	28.86	75.32	67.68	58.03	76.91	64.99	62.98	71.90	65.47	62.92	50.53	50.22	47.05	0.31

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APPENDIX F

INPUT FILE FOR ANSYS TUB MODEL

```
          Sample Input file for ANSYS analysis of the Tub.
          ************************************************

/COM,ANSYS REVISION  4.4          A 16     21.8342     1/ 4/1992

*****************************************************************************

Preprocessing phase:
********************

/PREP7
/TITLE,TUB

 *****************************************************************************

Model specification:
********************

ET,1,70
KAN,-1
KAY,4,1
ET,1,70
MP,KXX,1,.335
MP,DENS,1,56.18
C,1,.7643
MPLIST
ET,2,70
MP,KXX,2,1.08
MP,DENS,2,62.43
C,2,.35

*****************************************************************************

Model creation phase:
*********************

/SHOW
ON
N,1
N,5,,,.39
FILL,1,5
NGEN,7,5,1,5,1,.09
NPLOT
/PNUM,NODE,1
NPLOT
NGEN,4,35,1,35,1,,.01
EN,1,1,2,7,6,36,37,42,41
ENGEN,1,4,1,ALL
ENGEN,4,6,4,1,4,1
ENGEN,4,6,5,1,4,1
/TYPE,1,4
ENGEN,24,3,35,1,24,1
/TYPE,1,4
NGEN,2,140,1,5,5,-.00013
NDELE,141
NPLOT
NLIST
```

```
NGEN,2,140,1,,,-.00013
NGEN,2,137,5,,,-.00013
NGEN,2,33,110,,,-0.00013
NGEN,2,38,106,,,-.00013
TYPE,2
EN,73,1,141,142,5,106,144,143,110
NGEN,35,144,1,35,1,,-.00013
EN,74,1,2,7,6,145,146,151,150
ENGEN,1,4,1,74
ENGEN,4,6,5,74,77,1
NPLOT
NGEN,2,179,1,,,,,-.00013
NGEN,2,75,106,,,,,-.00013
NGEN,2,46,136,,,,,-.00013
NGEN,2,152,31,,,,,-.00013
EN,98,1,180,183,31,106,181,182,136
NGEN,2,153,31,,,,.00013
NGEN,2,49,136,,,,.00013
NGEN,2,46,140,,,,.00013
NGEN,2,152,35,,,,.00013
EN,99,31,184,187,35,136,185,186,140
NGEN,2,183,5,,,,,-.00013
NGEN,2,79,110,,,,,-.00013
NGEN,2,50,140,,,,,-.00013
NGEN,2,156,35,,,,,-.00013
/TYPE,1,4
NGEN,2,156,35,,,,,.00013
NGEN,2,183,5,,,,,.00013
NGEN,2,79,110,,,,,.00013
NGEN,2,50,140,,,,,.00013
EN,100,5,188,191,35,110,189,190,140

*************************************************************************
Time specification:
*******************

TIME,0
ITER,-1,0,1
KBC,1
KBC,1
NT,ALL,TEMP,77
LWRITE
TIME,.25
ITER,-15,1,1
KBC,1
NT,7,TEMP,194,,9
NT,12,TEMP,194,,14
NT,17,TEMP,194,,19
NT,22,TEMP,194
NTDELE,ALL,TEMP
NT,7,TEMP,194,,9
NT,12,TEMP,194,,14
NT,17,TEMP,194,,19
NT,22,TEMP,194,,24
NT,27,TEMP,194,,29
LWRITE
AFWRITE
FINISH

*************************************************************************
```

```
Solution phase:
***************

/INPUT,27
FINISH

*****************************************************************************
Postprocessing phase:
*********************

/POST1
SET,2,1
/VIEW,1,1,1,1
/VIEW,2
/WINDOW,1,TOP
/WINDOW,2,BOT
/TYPE,1,4
/TYPE,2,1
PLNSTR,TEMP
SET,2,15
PLNSTR,TEMP
PRTEMP
PRTEMP
FINISH
/EOF

*****************************************************************************
*****************************************************************************
```

APPENDIX G

OUTPUT ANSYS FILE FOR THE TUB

```
                SAMPLE ANSYS OUTPUT FILE FOR THE TUB.
                ************************************


     ***** ANSYS ANALYSIS DEFINITION (PREP7) *****

ENTER  RESUME               TO RESUME EXISTING MODEL
ENTER  /SHOW,DEVICE-NAME    TO ENABLE GRAPHIC DISPLAY
ENTER  FINISH               TO LEAVE PREP7
PRINTOUT KEY SET TO /GOPR (USE /NOPR TO SUPPRESS)

RESUME PREP7 DATA FROM FILE16   NAME=FILE16.DAT

*** PREP7 GLOBAL STATUS ***

TITLE= TUB
ANALYSIS TYPE=     -1
NUMBER OF ELEMENT TYPES=      2
   100 ELEMENTS CURRENTLY SELECTED.  MAX ELEMENT NUMBER =    100
   191 NODES CURRENTLY SELECTED.     MAX NODE NUMBER =      4931
     0 KEYPOINTS CURRENTLY SELECTED. MAX KEYPOINT NUMBER =    14
     0 LINE SEG CURRENTLY SELECTED.  MAX LINE SEG NUMBER =    17
     0 AREAS CURRENTLY SELECTED.     MAX AREA NUMBER =         4
MAXIMUM LINEAR PROPERTY NUMBER=      2
ACTIVE COORDINATE SYSTEM=      0   (CARTESIAN)

***  NOTE  ***
DATA CHECKED - NO ERRORS FOUND

*** PREP7 GLOBAL STATUS ***

TITLE= TUB
ANALYSIS TYPE=     -1
NUMBER OF ELEMENT TYPES=      2
   100 ELEMENTS CURRENTLY SELECTED.  MAX ELEMENT NUMBER =    100
   191 NODES CURRENTLY SELECTED.     MAX NODE NUMBER =      4931
     0 KEYPOINTS CURRENTLY SELECTED. MAX KEYPOINT NUMBER =    14
     0 LINE SEG CURRENTLY SELECTED.  MAX LINE SEG NUMBER =    17
     0 AREAS CURRENTLY SELECTED.     MAX AREA NUMBER =         4
MAXIMUM LINEAR PROPERTY NUMBER=      2
ACTIVE COORDINATE SYSTEM=      0   (CARTESIAN)

ANALYSIS DATA WRITTEN ON FILE27

ENTER  FINISH  TO LEAVE PREP7

IF YOU WANT TO RUN THIS ANALYSIS, ENTER AFTER PREP7 FINISH -
/CHECK       * (OPTIONAL) ENTER ONLY IF CHECK RUN IS DESIRED
/INPUT,27

THEN ENTER  FINISH  AT LOPT-INP PROMPT AT END OF ANALYSIS

***  NOTE  ***
FILE16.DAT WILL NOT BE RENAMED TO FILE16.OLD

ALL CURRENT PREP7 DATA WRITTEN TO FILE16   NAME= FILE16.DAT
```

```
 FOR POSSIBLE RESUME FROM THIS POINT

***** ROUTINE COMPLETED *****  CP =        41.200

SYSTEM= ROCHESTER INST.     REVISION= 4.4      A 16
FOR SUPPORT CALL DR. HANY GHONEIM  PHONE (716) 475-2544     TWX
CURRENT JOBNAME=FILE

***** INPUT SWITCHED FROM FILE05 TO FILE27  NAME=FILE27.DAT

NEW TITLE= TUB


OPTION AND TYPE PRINTOUT SUPPRESSED

NUMBER OF ELEMENT TYPES=   2

REAL CONSTANT PRINTOUT SUPPRESSED

NUMBER OF REAL CONSTANT SETS=   0

ELEMENT PRINTOUT SUPPRESSED

SWITCHED TO FIXED FORMAT INPUT
 MAXIMUM NODE NUMBER FOR AVAILABLE AUXILIARY MEMORY SIZE=     319898

 NUMBER OF ELEMENTS =    100     MAXIMUM NODE NUMBER USED =     191

NODE PRINTOUT SUPPRESSED

SWITCHED TO FIXED FORMAT INPUT

 XMIN=-0.1300E-03  XMAX= 0.5401      YMIN=-0.1300E-03  YMAX= 0.3000E-01  ZMIN=-
 MAXIMUM NODE NUMBER FOR AVAILABLE AUXILIARY MEMORY SIZE=     106632

PROPERTY PRINTOUT SUPPRESSED

MAXIMUM MATERIAL NUMBER=   2

M.D.O.F. PRINTOUT SUPPRESSED

NUMBER OF SPECIFIED MASTER D.O.F.=      0
TOTAL NUMBER OF MASTER D.O.F.    =      0

DISPLACEMENT B.C. PRINTOUT SUPPRESSED

FORCE B.C. PRINTOUT SUPPRESSED

PRESSURE PRINTOUT SUPPRESSED


***** LOAD SUMMARY -      0 TEMPERATURES       0 HEAT FLOWS    0 CONVECTIONS


ELEMENT FORMATION    ELEM=    98 L.S.=    1 ITER=     1  CP=    70.360

 RANGE OF ELEMENT MAXIMUM CONDUCTIVITY IN GLOBAL COORDINATES
```

MAXIMUM= 0.540010E+01 AT ELEMENT 100.
MINIMUM= 0.388944E-01 AT ELEMENT 67.

*** ELEMENT STIFFNESS FORMULATION TIMES

TYPE	NUMBER	STIF	TOTAL CP	AVE CP
1	72	70	1.320	0.018
2	28	70	0.500	0.018

TIME AT END OF ELEMENT STIFFNESS FORMULATION CP= 70.470

MAXIMUM IN-CORE WAVE FRONT ALLOWED FOR REQUESTED MEMORY SIZE= 200.

MAXIMUM IN-CORE WAVE FRONT= 80.

MATRIX SOLUTION TIMES

READ IN ELEMENT STIFFNESSES	CP=	0.670
NODAL COORD. TRANSFORMATION	CP=	0.000
MATRIX TRIANGULARIZATION	CP=	1.420

TIME AT END OF MATRIX TRIANGULARIZATION CP= 73.710
EQUATION SOLVER MAXIMUM PIVOT= 10.423 AT NODE 24. TEMP
EQUATION SOLVER MINIMUM PIVOT= 0.61418E-01 AT NODE 185. TEMP

***** TEMPERATURE SOLUTION ***** TIME = 0.30000E-01 LOAD STEP= 1 IT

NODE	TEMP	NODE	TEMP	NODE	TEMP	NODE	
1	77.000	2	77.000	3	77.000	4	7
6	77.000	7	77.000	8	77.000	9	7
11	77.000	12	77.000	13	77.000	14	7
16	77.000	17	77.000	18	77.000	19	7
21	77.000	22	77.000	23	77.000	24	7
26	77.000	27	77.000	28	77.000	29	7
31	77.000	32	77.000	33	77.000	34	7
36	77.000	37	77.000	38	77.000	39	7
41	77.000	42	77.000	43	77.000	44	7
46	77.000	47	77.000	48	77.000	49	7
51	77.000	52	77.000	53	77.000	54	7
56	77.000	57	77.000	58	77.000	59	7
61	77.000	62	77.000	63	77.000	64	7
66	77.000	67	77.000	68	77.000	69	7
71	77.000	72	77.000	73	77.000	74	7
76	77.000	77	77.000	78	77.000	79	7
81	77.000	82	77.000	83	77.000	84	7
86	77.000	87	77.000	88	77.000	89	7
91	77.000	92	77.000	93	77.000	94	7
96	77.000	97	77.000	98	77.000	99	7
101	77.000	102	77.000	103	77.000	104	7
106	77.000	107	77.000	108	77.000	109	7
111	77.000	112	77.000	113	77.000	114	7
116	77.000	117	77.000	118	77.000	119	7
121	77.000	122	77.000	123	77.000	124	7

```
 126   77.000        127   77.000        128   77.000        129   7
 131   77.000        132   77.000        133   77.000        134   7
 136   77.000        137   77.000        138   77.000        139   7
 141   77.000        142   77.000        143   77.000        144   7
 146   77.000        147   77.000        148   77.000        149   7
 151   77.000        152   77.000        153   77.000        154   7
 156   77.000        157   77.000        158   77.000        159   7
 161   77.000        162   77.000        163   77.000        164   7
 166   77.000        167   77.000        168   77.000        169   7
 171   77.000        172   77.000        173   77.000        174   7
 176   77.000        177   77.000        178   77.000        179   7
 181   77.000        182   77.000        183   77.000        184   7
 186   77.000        187   77.000        188   77.000        189   7
 191   77.000

 MAXIMUM TEMPERATURE=  77.000     AT NODE   185
 MINIMUM TEMPERATURE=  77.000     AT NODE   149

 ***** ELEMENT HEAT FLOW RATES *****  TIME =  0.300000E-01   LOAD STEP=    1

EL=     1  NODES=     1     2     7     6    36    37    42    41  MAT=  1  VOL
 TG(X,Y,Z,SUM)=   0.2487E-11  0.5436E-10 -0.4118E-11  0.5457E-10 TF(X,Y,Z,SUM)=

EL=     2  NODES=     2     3     8     7    37    38    43    42  MAT=  1  VOL
 TG(X,Y,Z,SUM)=   0.1283E-10  0.7567E-10 -0.9838E-12  0.7676E-10 TF(X,Y,Z,SUM)=

EL=     3  NODES=     3     4     9     8    38    39    44    43  MAT=  1  VOL
 TG(X,Y,Z,SUM)=   0.1172E-10  0.8633E-10 -0.2004E-11  0.8715E-10 TF(X,Y,Z,SUM)=

EL=     4  NODES=     4     5    10     9    39    40    45    44  MAT=  1  VOL
 TG(X,Y,Z,SUM)=   0.1745E-10  0.6324E-10  0.6194E-11  0.6589E-10 TF(X,Y,Z,SUM)=

EL=     5  NODES=     6     7    12    11    41    42    47    46  MAT=  1  VOL
 TG(X,Y,Z,SUM)=   0.1105E-11  0.3908E-10  0.7288E-11  0.3977E-10 TF(X,Y,Z,SUM)=

EL=     6  NODES=     7     8    13    12    42    43    48    47  MAT=  1  VOL
 TG(X,Y,Z,SUM)=   0.1303E-11  0.5329E-11 -0.2660E-11  0.6097E-11 TF(X,Y,Z,SUM)=

EL=     7  NODES=     8     9    14    13    43    44    49    48  MAT=  1  VOL
 TG(X,Y,Z,SUM)=  -0.1184E-11  0.4192E-10 -0.3644E-11  0.4210E-10 TF(X,Y,Z,SUM)=

EL=     8  NODES=     9    10    15    14    44    45    50    49  MAT=  1  VOL
 TG(X,Y,Z,SUM)=  -0.8448E-11  0.2416E-10  0.6413E-11  0.2638E-10 TF(X,Y,Z,SUM)=

EL=     9  NODES=    11    12    17    16    46    47    52    51  MAT=  1  VOL
 TG(X,Y,Z,SUM)=   0.3118E-11  0.1457E-10  0.5138E-11  0.1576E-10 TF(X,Y,Z,SUM)=

EL=    10  NODES=    12    13    18    17    47    48    53    52  MAT=  1  VOL
 TG(X,Y,Z,SUM)=  -0.7184E-11  0.4050E-10 -0.9838E-11  0.4229E-10 TF(X,Y,Z,SUM)=

EL=    11  NODES=    13    14    19    18    48    49    54    53  MAT=  1  VOL
 TG(X,Y,Z,SUM)=   0.1026E-11  0.4690E-10  0.8818E-11  0.4773E-10 TF(X,Y,Z,SUM)=

EL=    12  NODES=    14    15    20    19    49    50    55    54  MAT=  1  VOL
 TG(X,Y,Z,SUM)=   0.8763E-11  0.3695E-10 -0.5611E-11  0.3839E-10 TF(X,Y,Z,SUM)=

EL=    13  NODES=    16    17    22    21    51    52    57    56  MAT=  1  VOL
 TG(X,Y,Z,SUM)=  -0.6316E-11  0.2984E-10  0.3279E-11  0.3068E-10 TF(X,Y,Z,SUM)=
```

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APPENDIX H

COMPARISON BETWEEN EXPERIMENTAL RESULTS AND ANSYS PREDICTIONS

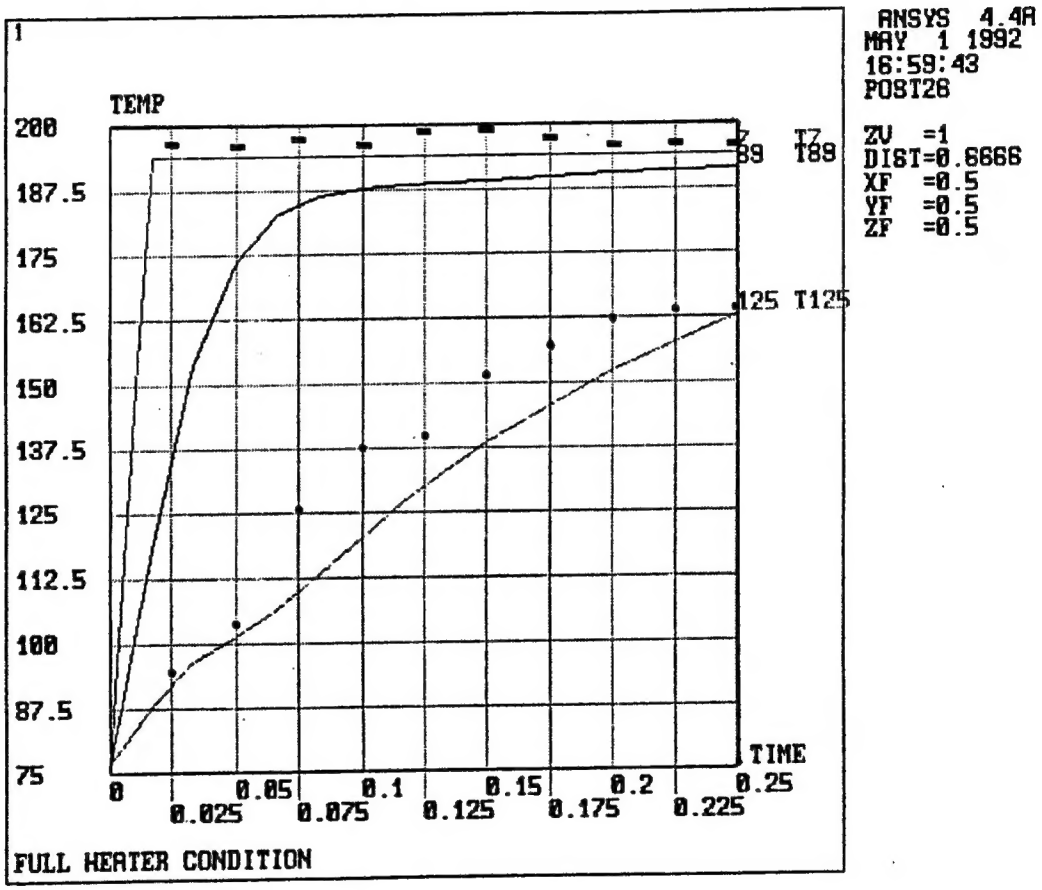

Figure H-1. Temperature history for the full heater experiment

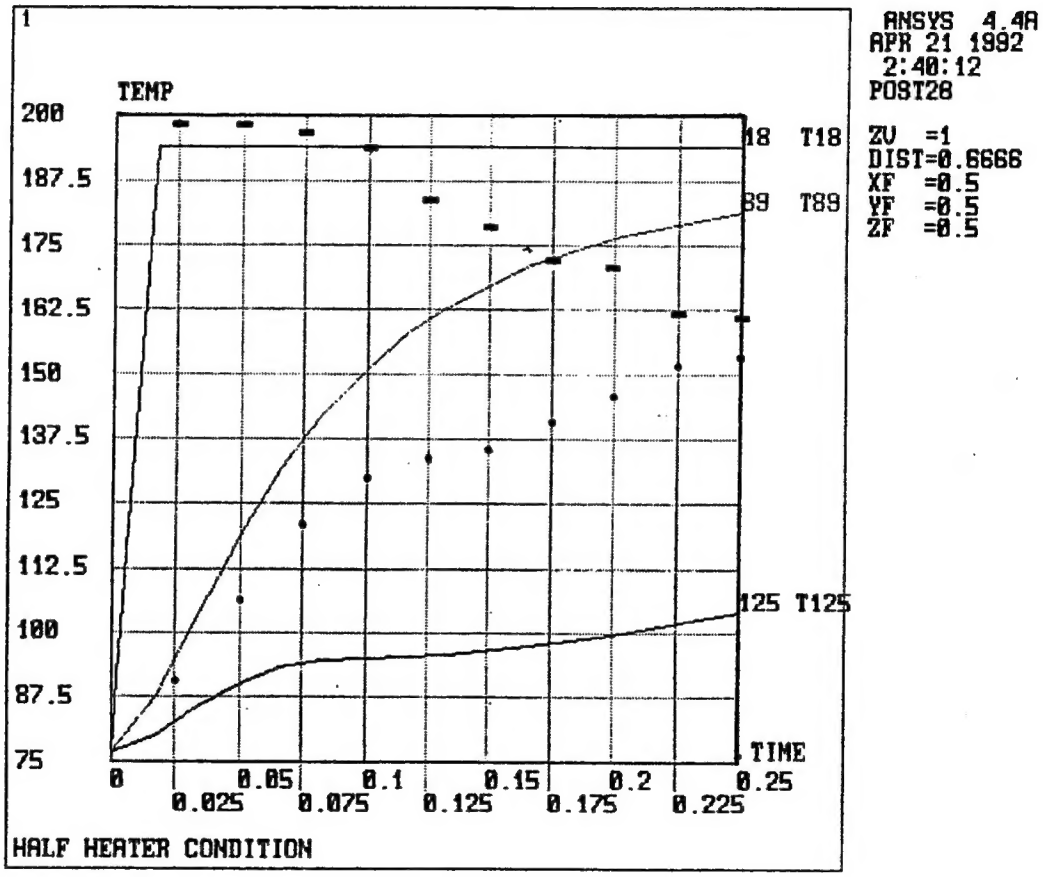

Figure H-2. Temperature history for the half heater condition

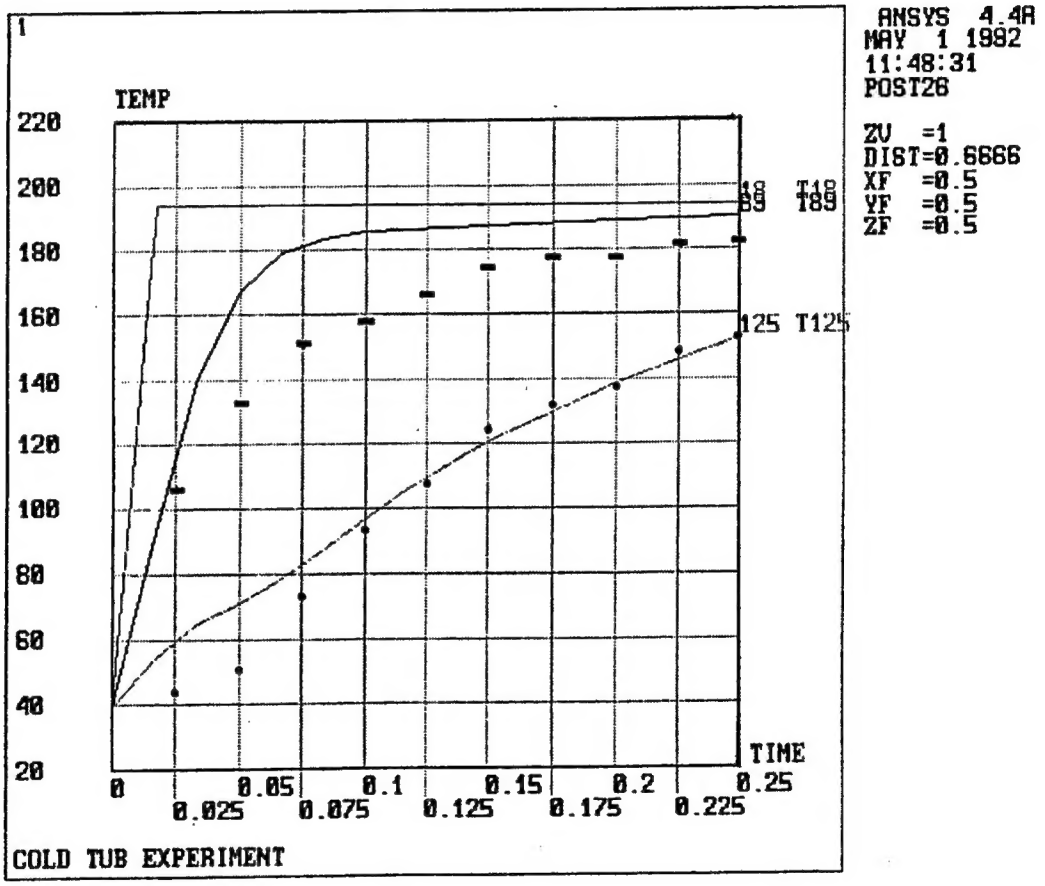

Figure H-3. Temperature history for the cold tub experiment